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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 12380, 12439, 12506, 12523, 12700, 12749, and 12753.

12274 (ANL-7242) DETECTION SENSITIVITIES IN NUCLEAR ACTIVATION WITH AN ISOTOPIC NEUTRON SOURCE (WITH A COLLECTION OF γ-RAY SPECTRA). Wing, James A.; Wahlgren, M. A. (Argonne National Lab., Ill.). Aug. 1966. Contract W-31-109-eng-38. 111p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The relative detection sensitivities of seventy-three chemical elements (all the radioactively stable elements except beryllium, lutetium, osmium, and the noble gases) were determined using an $^{241}Am-^{242}Cm-Be$ neutron source. The sensitivities were obtained for three experimental conditions: 5-min irradiation, 6-sec cooling, 2-min count; 5-min irradiation, 4.9-min cooling, 20-min count; and one-hour irradiation, one-hour cooling, 40-min count. The induced radioactivities were measured with a 10-cm by 10-cm NaI(Tl) crystal. The observed γ spectra are presented. The counts in the photopeaks, per gram of target element, are tabulated versus the gamma energies of the product nuclides. Self-absorption of neutrons and attenuation of γ rays by the target matrices were investigated with Teflon and aluminum samples. Reproducibility of the analytical method was 0.92%. (auth)

12275 (AWRE-O-87/66) AN ASSESSMENT OF ATOMIC FLUORESCENCE SPECTROMETRY AS A METHOD OF TRACE ANALYSIS. Goodfellow, G. I. (Atomic Weapons Research Establishment, Aldermaston (England)). Jan. 1967. 20p. Dep. mn. BIS $0.60. HMSO 3s. 0d.

The method of atomic fluorescence spectrometry was investigated, and its potential as an analytical method for trace analysis was assessed. Results obtained by addition of certain metals, including alkali metals, to Zn, Cd, and Cu are described. It was concluded that even with the simplest of apparatus, the method can give very good sensitivities for elements in solution. (P.C.H.)

12276 (CONF-650405) PROCEEDINGS OF 1965 INTERNATIONAL CONFERENCE ON MODERN TRENDS IN ACTIVATION ANALYSIS, COLLEGE STATION, TEXAS, APRIL 19–22, 1965. (Texas Agricultural and Mechanical Univ., College Station. Activation Analysis Research Lab.). Contract AT(40-1)-2671. 390p. Texas A and M Univ. $15.00.

Seventy-two papers are presented. Separate abstracts were prepared for 41 of the papers. The remaining 31 papers were previously abstracted for NSA. For abstract numbers of the individual papers see CONF-650405 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 12294–12331, 12506, 12719, and 13788.

12277 (CONF-651008–, pp 1-19) URINALYSIS BY ION EXCHANGE. Henley, L. C. (Oak Ridge National Lab., Tenn.).

A method of urinalysis was developed for determination of several of the more hazardous nuclides from a single urine sample. The alkaline earth and the rare earth type elements are precipitated directly from urine as the basic phosphate. The precipitate is wet ashed with nitric acid. The ashed precipitate is dissolved in 10M hydrochloric acid and passed over a small anion resin column. Protactinium, uranium, neptunium, and plutonium are absorbed. Under these conditions no other actinide or lanthanide is absorbed. Plutonium, protactinium, neptunium, and uranium are eluted selectively and are determined individually by alpha counting. The 10M hydrochloric acid effluent contains the alkaline earths, the tri-valent actinides and the lanthanide series. This solution may be dried and counted directly for beta or further separations may be made for the determination of other alpha emitting actinides and for strontium. (auth)

12278 (CONF-651008–, pp 20-34) RECENT ADVANCES IN THE BIO-ASSAY FIELD AT A.E.R.E., HARWELL. Morgan, A.; Eakins, J. D. (Atomic Energy Research Establishment, Harwell (England)).

Radiochemical procedures are described for the simultaneous determination of ^{55}Fe and ^{59}Fe in blood; ^{90}Sr in urine; ^{227}Ac in urine; and ^{231}Pa in urine. The development of a counter with silicon junction diode detector for α counting is reported. The advantage of using γ scintillation spectrometry for the assay of untreated samples of urine from persons exposed to γ-emitting materials that are likely to be excreted in urine is discussed. (C.H.)

12279 (CONF-651008–, pp 35-47) SYSTEMATIC ERRORS IN "RECOVERY" AND "DETECTION EFFICIENCY" AS RELATED TO RADIOCHEMICAL ANALYSIS. Currie, L. A. (National Bureau of Standards, Washington, D. C.).

Evidence of systematic error in the assay of thorium arose when the chemical yield from a biological sample seemed to depend on the detection method. When α counting and spectrophotometry were applied to different aliquots of the same sample, following chemical purification, the discordant chemical yields pointed to variations in detection efficiency. The difficulty arises because determination of the chemical yield is based on known disintegration rates of a spike, which was chemically processed, and on the detection efficiency, which is generally determined by means of a standard which may not be chemically processed. Systematic errors in recovery and detection efficiency may be eliminated by direct measurement of the overall yield, or the product of chemical yield and detection efficiency, or by the accurate determination of both the chemical yield and the detection efficiency by such methods as isotope dilution and internal (efficiency) monitoring, respectively. Experimental illustrations are given for determination of thorium and of ^{14}C. (auth)

12280 (CONF-651008–, pp 48-68) ^{85}Sr TRACER METHOD FOR DETERMINATION OF ^{90}Sr. A Review of Three Years Experience. (Eberline Instrument Corp., Santa Fe, N. Mex.).

Approximately 4000 samples were analyzed for ^{90}Sr. Of these, more than half were analyzed in duplicate, some were analyzed in triplicate and others were analyzed as a single aliquot. In all cases, ^{85}Sr was used as an internal tracer to measure the ^{90}Sr recovery. Yttrium carrier was used to determine ^{90}Y recovery. A sufficient number of duplicate determinations were made for milk, soil, and vegetation to justify a statistical review of the data. The accuracy, selectivity, and sensitivity of the procedures in routine use were also reviewed. (auth)

12281 (COO-581-11) THE DETERMINATION OF ISOTOPIC URANIUM AND THORIUM COMPOSITIONS IN MARINE CARBONATES BY ALPHA SPECTROMETRY. Cheng, Mary Mei-Ling Huang (Washington Univ., St. Louis, Mo. Dept. of Chemistry). Apr. 16, 1966. Contract AT(11-1)-581. 11p. (CONF-660453-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 3rd Annual Symposium on Analytical Chemistry, St. Louis, Mo.

Uranium and thorium in the sample solution are coprecipitated with iron and aluminum hydroxides. Separation and the purification

of the two elements are carried out by solvent extraction and ion exchange. The purified element is then electroplated onto a planchet to form a very thin sample source for alpha spectrometry. The activities of the uranium and thorium isotopes are determined by alpha spectrometry using silicon surface-barrier semiconductor radiation detector, which is coupled through a low-noise amplifier system to a 400-channel pulse-height analyzer. (auth)

12282 (EUR-3118.f) REVUE DES TRAITEMENTS APPLIQUES AUX ELECTRODES UTILISEES POUR LES TITRAGES POTENTIOMETRIQUES (Application au cas Particulier de l'Uranium). (Review of Treatments Applied to Electrodes Used for Potentiometric Analysis (With Particular Reference to Uranium)). Le Duigou, Y. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). June 21, 1966. 8p. (In French). Dep. mn.

A literature review is given of different conditioning procedures applied to electrodes used in potentiometric end-point determinations with special references to uranium titrations. (auth)

12283 (JEN-170-DQ/I-60) ESTUDIO SOBRE LA PREPARACION Y ESTABILIDAD DE LAS MUESTRAS DE CARBURO DE URANIO PARA LA DETERMINACION DE OXIGENO, HIDROGENO Y NITROGENO POR FUSION EN ALTO VACIO. (Study on the Preparation and Stability of Uranium Carbide Samples for the Determination of Oxygen, Hydrogen, and Nitrogen by Fusion Under High Vacuum). Perez Garcia, M. (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1966. 14p. (In Spanish). Dep. mn.

In view of the high reactivity of uranium carbide, the method used for preparing the sample for analysis of its gas content has a decisive influence on the analytical results. The variation in the O_2, H_2, and N_2 content of the uranium carbide has been studied with the methods utilized for the sample preparation (grinding and cutting). Furthermore, these variations were studied as a function of time, depending on the medium of storage of the uranium carbide: normal atmosphere and argon atmosphere. In order to determine the O_2, H_2, and N_2, the method of analysis by fusion under high vacuum, using a Pt bath which has already been applied to the analysis of uranium and some of its compounds. (auth)

12284 (ORNL-3904(Rev.1)) CUMULATIVE INDEXES TO THE ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORTS, 1964-1966. Raaen, Helen P.; Haas, Ann K. (eds.) (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 105p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Cumulative keyword and author indexes to the annual progress reports from the Analytical Chemistry Division of ORNL are included. The reports indexed are for periods following November 15, 1963. (P.C.H.)

12285 (ORNL-4039) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1966. Raaen, Helen P. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 168p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for research on: analytical instrumentation; effects of radiation on analytical methods; analytical chemistry for reactor projects; special analytical methods; analytical biochemistry; x-ray and spectrochemical analyses; mass spectrometry; optical and electron microscopy; nuclear and radiochemical analyses; inorganic and organic preparations; mass spectrometric analyses; spectrochemical analysis laboratory; and process analyses. The ORNL master analytical manual is appended. (P.C.H.)

12286 (ORO-3192-6) PROGRESS REPORT [ON ANALYSIS OF ATMOSPHERIC SAMPLES], AUGUST 20, 1965-OCTOBER 31, 1966. Musgrave, Burdon C. (Arkansas Univ., Fayetteville). Oct. 31, 1966. Contract AT(40-1)-3192. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Analysis of liquid O_2 samples from Neosho, Missouri, was continued. These samples were processed for methane, ethane, and Kr; the T/H ratios and ^{85}Kr levels respectively were measured. A system for recovery of trace gases by direct processing of large volumes of air was developed. Some initial results are available on this system. Results are reported on the problem of the photochemical lifetime of methane and the ^{3}H content of formaldehyde in the atmosphere. A number of atmosphere hydrogen samples are reported and a correlation of the T/H to D/H ratios was attempted. An atmosphere sampling laboratory was established at the top of Mt. Evans, Colorado. (auth)

12287 (STI-DOC-10/62) ANALYTICAL CHEMISTRY OF NUCLEAR MATERIALS. Second Panel Report, Held in Vienna, March 23-26, 1964. Technical Reports Series No. 62. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 140p. IAEA: $3.00; Austrian Schillings 78,-; £1.1.2; F Fr 14,70; DM 12,-.

Analysis of nuclear materials is discussed under the following headings: spectrographic techniques for determination of impurities in uranium, spectrophotometric analysis of nuclear materials, application of methods other than spectrography and spectrophotometry to analysis of the intercomparison sample, mass spectrometric determination of trace impurities, determination of uranium with special reference to coulometry, preparation of analyzed samples of nuclear materials with special reference to ores, and preparation of standard samples for spectrographic analysis. (M.C.G.)

12288 (TID-7015(Indexes)(Rev.4)) INDEXES TO THE OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL (1953-1966). Raaen, Helen P.; Klein, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 186p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

12289 (TID-7015(Suppl.9)) OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 148p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two new methods to be added to the Oak Ridge National Laboratory Master Analytical Manual and 3 revisions to previously issued methods are included. Methods of hot-cell dissolution of radioactive materials and determination of particle-size distribution in thorium oxide by neutron activation and centrifugation are given. Revisions are given for determination of cobalt, zirconium, and manganese by neutron activation. (M.C.G.)

12290 (UCRL-16898, pp 64-71) SERUM-LIPOPROTEIN DISTRIBUTION AND PROTEIN ANALYSIS BY REFRACTOMETRY. Lindgren, Frank T.; Freeman, Norman K.; Wills, Robert D.; Ewing, Alicia M.; Jensen, Lin C. (California Univ., Berkeley. Lawrence Radiation Lab.).

The use of refractometry for measurement of proteins in blood serum is discussed, with emphasis on the influence of lipoproteins on the accuracy of measurements of total proteins. A procedure is described for converting the measured refractive increment of each lipoprotein class to the appropriate value it would have in a serum background environment. Results are reported from measurements of mean values and standard deviations in serum proteins in nonfasting normal males and females using refractometry data or calculations by other formulae. Lipoproteins were isolated and measured either by refractometry or ultracentrifuge methods with corrections made by means of a computer program. The data indicate that neither total serum proteins nor total real protein can be measured accurately by serum refractometry unless the total content of serum lipoproteins is considered. Serum refractometry can be done on one drop of serum and the procedure has been partly automated. (22 references.) (C.H.)

12291 THERMAL IONIZATION MASS SPECTROMETRY IN ANALYTICAL CHEMISTRY. Woodward, H. (Australian Atomic Energy Commission, Sydney). At. Energy Austral., 10: 16-20 (Jan. 1967).

The principles of thermal ionization mass spectrometry are explained, and some of the uses and limitations of the technique described. The specificity, high sensitivity, and precision of the operation makes the combination of isotope dilution and mass spectrometry a very powerful tool in analytical chemistry. (D.H.M.)

12292 DETERMINATION OF SELENIUM IN AMINO ACIDS AT THE 0.1 ppm LEVEL BY PULSED-NEUTRON ACTIVATION. Maxia, Vera; Rollier, M. A. (Univ. of Pavia, Italy). Nucl. Appl., 3: 187-90(Mar. 1967).

The determination of selenium in amino acids in the range from 1.0 to 0.1 ppM is of significance for biomedical investigations. The improvement of sensitivity in neutron activation producing the ^{77m}Se nuclide when the sample is activated by reactor pulses is used. Neutron pulses of an integrated energy averaging 13 MW sec from a TRIGA Mark II reactor were used. Actual biological samples were simulated by adding ppM amounts of sodium selenite to 1-g amounts of glycine. Results are reported that show a percentage standard deviation of mean value of ±1.3%. (auth)

12293 PHOTOMETRIC DETERMINATION OF URANIUM IN NATURAL WATERS USING ARSENAZO III. Nemodruk, A. A.; Deberdeeva, R. Yu. Radiokhimiya, 8: 248-51(1966). (In Russian).

A photometric method for the determination of U in natural water, including the preliminary concentration of U by Co, precipitation with iron hydroxide, is described. The precipitate obtained was dissolved in hydrochloric acid, the U was separated by extraction with tributyl phosphate in the presence of ammonium nitrate, after which it was reextracted with weakly alkaline solu-

tions of Arsenazo III, the reextracted material was diluted with equal volume of concentrated nitric acid, and the optical density of the mixture obtained was measured on the spectrometer at 656 mμ or on the photoelectrocolorimeter FEK-N-57 with red filters. By measurement of the optical density on the spectrophotometer the method makes it possible to determine U in water at concentrations of 0.5 μg/l; by use of the photoelectrocolorimeter the sensitivity of the method is 1.0 μg/l. The mean error does not exceed 7%. (tr-auth)

12294 MEASUREMENT OF FIBER BLEND VARIABILITY BY ACTIVATION ANALYSIS. Armstrong, Arthur A, Jr.; Bogdan, John F.; Chudgar, Ashvin J. (North Carolina State Coll., Raleigh). pp 9-12 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A study was made to measure the lengthwise variability of polyester in polyester–cotton blends using activation analysis. Samples taken at different points in the spinning process were activated in a nuclear reactor. After several days of decay the only significant gamma activity was from ^{122}Sb present in the polyester. The variability of the polyester component was estimated by measuring the variability in counting rate along the length of each sample using a NaI detector, single-channel analyzer, rate meter and recorder. A Uster evenness tester, which measures capacitance, was used to measure the total variability of the material. By statistical analysis the cotton component variability was calculated. Theoretical equations were developed showing the effect of different variables operating in the method. Various errors were discussed and recommendations were made on ways to improve the accuracy of the measurements. (auth)

12295 DETERMINATION OF TRACES OF ARSENIC IN GERMANIUM BY NEUTRON ACTIVATION ANALYSIS. De Soete, D.; De Neve, R.; Hoste, J. (Ghent Univ.). pp 31-8 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Neutron activation analysis was used for determination of arsenic in germanium and germanium dioxide by gamma or beta spectrometry using ^{77}As as an internal standard. In the gamma-spectrometric technique the 1.21-MeV gamma of ^{76}As was measured against the 0.246-MeV gamma of ^{77}As. For arsenic concentrations higher than 30 ppM a Compton-compensated spectrometer was used and the content directly computed from the ratio of the photopeaks. This technique allowed determinations down to 50 ppB. Below this level beta spectrometry was preferred. The use of an absorber was required to avoid pile-up of the high-activity level of the beta radiation of ^{77}As. The lower limit for the arsenic determination was estimated at 10^{-9} g, i.e., 1 ppB for a 1-g sample. (auth)

12296 FAST-NEUTRON ACTIVATION ANALYSIS IN MOLTEN-SALT ELECTROMETALLURGICAL RESEARCH. Broadhead, K. G.; Shanks, D. E.; Heady, H. H. (Bureau of Mines, Reno, Nev.). pp 39-43 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Applications of fast-neutron activation analysis and the potential of this tool in facilitating and improving the analytical support facet of electrometallurgical research are reviewed. Sodium, chlorine, silicon, and fluorine are determined routinely in samples taken from molten-salt baths used in the electrowinning of tungsten and molybdenum. The baths consist primarily of sodium and potassium chlorides or fluorides, kryolite, sodium borates and silicates plus the oxides of the tungsten or molybdenum. Spectrum stripping is used to correct for the mutual interferences in the determination of silicon, fluorine and sodium. Fluoride electrolytes used in the electrowinning of the individual rare-earth metals are normally composed of a mixture of LiF, BaF_2, and the respective rare-earth fluoride. These electrolytes are analyzed for all the major constituents except lithium. In determining fluorine a correction for oxygen interference may be required. Trace amounts of oxygen, fluorine, phosphorous, sodium, silicon and aluminum are determined in various metals and compounds. The analysis of oxygen is facilitated by manually transferring the activated metal sample from the plastic container to the scintillation detector in order to eliminate the background effects of the container. Oxygen can be determined at the 10-ppM level with a precision of ±50%. (P.C.S.)

12297 RAPID RADIOCHEMICAL SEPARATION PROCEDURES FOR ACTIVATION ANALYSIS INDICATORS. Wahl, Werner H.; Molinski, Victor J.; Arino, Hirofumi (Union Carbide Corp., Tuxedo, N. Y.). pp 44-7 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Rapid procedures were developed for the radiochemical separation of Al, Mg, Ti, V, and Nb from neutron-irradiated materials. Emphasis was given to those elements whose only radioisotope produced by radiative neutron capture is short-lived (less than 10 min). Satisfactory results were obtained when these methods were used on ores and minerals. The procedures may be useful in other complex systems. (P.C.S.)

12298 DETERMINATION OF IMPURITIES IN HIGH-PURITY NIOBIUM AND TANTALUM BY RADIOACTIVATION ANALYSIS. Kawashima, Toshi (Electrical Communication Lab., Tokyo). pp 61-5 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Neutron activation analyses followed by gamma spectrometry were developed for the determination of trace impurities in high-purity niobium and tantalum samples. (auth)

12299 DETERMINATION OF SELENIUM IN HUMAN TISSUES BY MEANS OF ACTIVATION ANALYSIS. Tomlinson, R. H.; Dickson, R. C. (McMaster Univ., Hamilton, Ontario). pp 66-70 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The protein-bound selenium content of the plasma and cell fractions of the blood of 94 normal individuals was determined by means of neutron-activation analysis based on the oxygen content of the samples. A normal range was established, and variations with sex, living conditions, and body character were noted. Semiquantitative analyses of individual plasma proteins and other human tissues for selenium indicated that certain tissues have a significantly higher selenium-to-sulfur ratio than others. The data provided further evidence of the essential nature of selenium in human metabolism. (auth)

12300 NUCLEAR ANALYSIS SYSTEM FOR COAL. Martin, T. C.; Morgan, I. L.; Hall, J. D. (Texas Nuclear Corp., Austin). pp 71-7 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A closed-loop nuclear-analyzing system was designed to measure the carbon, oxygen, silicon, and aluminum content of coal on a conveyor belt. This was accomplished by utilizing a prompt spectrometer positioned near the generator and a delayed gamma spectrometer located about 40 sec downstream. The carbon and oxygen contents were measured by the technique of fast-neutron inelastic scattering while fast-neutron activation analysis was used to measure the aluminum and silicon content. Feasibility studies showed that the calorific value of coal can be determined fairly accurately by the carbon content, and the ash content can be related to the amount of aluminum and silicon. The oxygen content gives some measure of the moisture content especially in wet coals. (P.C.S.)

12301 STUDIES OF THE GAMMA SPECTRUM OF NEUTRON-IRRADIATED BLOOD. Plantin, Lars-Olof (King Gustaf V Research Inst., Stockholm). pp 91-6 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Samples of whole blood were irradiated in a nuclear reactor. The gamma radiation of the induced radioactivity was studied for obtaining qualitative and quantitative information about trace elements. Theoretical computed spectra were treated by computer. Programming is under development, but present methods involved manual control and instruction in the computer program to allow for 2% channel drift. (P.C.S.)

12302 PAPER-CHROMATOGRAPHIC SEPARATION METHOD FOR ACTIVATION ANALYSIS. Bock-Werthmann, W.; Schulze, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 120-2 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Investigations of a wide range of inorganic/organic liquid mixtures were made to select a procedure to separate a large number of elements into groups of good radiochemical purity. The number of elements in each group was usually so small that individual radioactivities could be separated easily by subsequent γ spectrometry or decay curve analysis. Results showed that the mixture 420 ml ethanol, 30 ml HCl, and 150 ml H_2O gave best results. Mixture did not store well and quite different conditions were found if percentages varied slightly. In some analyses individual radiochemically pure elements were obtained. When the induced radioactivities were of short half-life, the chromatographic separation had to be made prior to activation. Under these conditions the blank introduced by the filter paper resulted in a much less favorable sensitivity, even when chromatographic paper with the lowest available trace-element content was used. (P.C.S.)

12303 NEUTRON ACTIVATION ANALYSIS OF IRIDIUM IN OSMIUM AND EXPERIMENTAL STUDY OF THE SECOND-ORDER REACTION. Gijbels, R.; Hoste, J. pp 129-33 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A radiochemical separation of iridium from other elements and especially osmium is described, based on selective distillation. In a sulfuric acid–sodium bromate solution 99.997 to 99.998% of the osmium and more than 98.5% of the ruthenium distills in 1.5 hr, whereas more than 99.995% of the iridium remains in the residue. After addition of perchloric acid, 95 to 98% of the iridium can be volatilized after 2 hr in a stream of chlorine at 200°C if not more than ~50 μg are present. No other elements were found to distill. This technique offers selective separation of microgram amounts of iridium after removal of the volatile platinum metals ruthenium and osmium. The method was used for the experimental study of the second-order reaction $^{190}Os(n,\gamma)^{191}Os \xrightarrow{\beta^-} {}^{191}Ir(n,\gamma)^{192}Ir$ by simultaneous irradiation of purified osmium sponge with very low iridium content (< 2 ppB) and iridium standards during 1 to 10 days. A procedure is described for the preparation of this "iridium-free" osmium sponge. The apparent iridium content as measured from the ^{192}Ir activity was found to be proportional to the square of the irradiation time and corresponded to ca. 5, 45, 80, 135, and 210 ppB for irradiation periods of 2, 4, 6, 8, and 10 days, respectively, at a neutron flux of 4×10^{11} n/cm^2/sec. Extrapolation to $t_{irr} \to 0$ gave the iridium content originally present as an impurity namely less than 2 ppB. (auth)

12304 FAST-SUM COINCIDENCE SPECTROMETER AND SENSITIVITY COMPILATION FOR ACTIVATION ANALYSIS. Wahlgren, M.; Wing, J.; Hines, J. pp 134-9 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A tabulation of thermal-neutron sensitivities for several irradiation times and for alternative counting techniques was prepared. The results are expressed as counts min^{-1} μg^{-1} for a 4-π beta counter for a 3-in. × 3-in. NaI(Tl) detector at 3 and 9 cm and for gamma-gamma, beta-gamma and triple-coincidence counting with 4-π beta geometry and 3-in. × 3-in. NaI(Tl) detectors at a standard 3-cm distance. Coincident gamma energies and sum-peak energies are presented graphically versus half-life for rapid estimation and identification of interfering activities. The computation was based on known thermal-neutron cross sections and available decay properties of the product and decay daughter nuclides. The use of the compilation in rapid evaluation of activation problems is discussed for a number of typical samples. (auth)

12305 NEW DEVELOPMENTS IN THE APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO PROBLEMS IN SCIENTIFIC CRIME DETECTION. Bryan, D. E.; Guinn, V. P.; Settle, D. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 140-5 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Some findings in the investigation of forensic-science applications of neutron-activation analysis are summarized. Present work on the possibility of trace-element labeling of gunpowder is discussed. (P.C.S.)

12306 LIQUID AND PLASTIC SCINTILLATION COUNTING FOR OXYGEN BY NEUTRON ACTIVATION ANALYSIS. Iddings, Frank A. (Humble Oil and Refining Co., Baton Rouge, La.). pp 146-8 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An increase in oxygen-analysis sensitivity for small samples activated by 14-MeV neutrons was obtained by using liquid or plastic scintillators for beta counting of the resultant ^{16}N rather than NaI(Tl) for gamma counting. Advantages for samples from petroleum and chemical research are discussed. Use of multichannel-spectrum analysis or pulse-height discrimination minimized interferences. Spectra from various arrangements as well as sensitivity and precision data are presented. (auth)

12307 RAPID ACTIVATION ANALYSIS METHOD FOR SODIUM IN ORGANIC MATERIALS. Iddings, Frank A.; Wade, J. T. (Humble Oil and Refining Co., Baton Rouge, La.). pp 149-51 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A method for the determination of sodium through use of the reaction $^{23}Na(n,\alpha)^{20}F$ is described. The advantages of speed, simplicity of sample preparation, and accuracy are illustrated. Especially noted are the advantages for samples containing both organically and inorganically bound sodium and polymeric materials. The sensitivity and long-term accuracy for the method as used routinely with an instrumental 14-MeV neutron source is presented. Minimization of interferences through use of the short (10.7 sec) half-life of the ^{20}F and its fairly high-energy gamma (1.63 MeV) is reported. (auth)

12308 DESIGN OF APPARATUS FOR POSTIRRADIATION CHEMICAL TREATMENTS IN ACTIVATION ANALYSIS. Burnett, William T. Jr.; Cohan, Morton D. (National Naval Medical Center, Bethesda, Md.). pp 159-63 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Designs of several gadgets to be used in automatic and semi-automatic systems of activation analysis are presented. Several models of a digester-planchet, to be used in wet-ashing small samples of biological materials, are described. A new version of a Teflon ion-exchange unit is presented. Accessories to these units are also described. (J.G.B.)

12309 CORRELATION OF PHYSICAL PROPERTIES OF RUBBER WITH NITROGEN CONTENT BY MEANS OF NEUTRON-ACTIVATION ANALYSIS. Walker, L. J.; Eggebraaten, V. L. (Boeing Co., Seattle). pp 169-71 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Neutron activation analysis was developed for routine determinations of nitrogen in rubberized-sealant material. Simplicity of operation and good reproducibility are characteristic of the method. A rotating sample rack was used in order to expose all samples to a uniform flux. A 5-min irradiation time was used followed by a 2-min decay interval to eliminate possible oxygen interference. The samples were counted for 2-min periods with a 3-in. dia NaI(Tl) crystal connected to a single-channel analyzer. The only computation required was the correction for ^{13}N 10-min half-life decay after which the nitrogen content of the samples became directly proportional to the 0.51-MeV gamma activity. The total time required for analysis was 20 min per set of four samples. Correlation between the physical properties of tensile strength and elongation versus the nitrogen content of the samples was established. (J.G.B.)

12310 DETERMINATION OF INDIUM AND THALLIUM IN ZINC AND ZINC SALTS. Gibbons, D.; Lawson, D. (United Kingdom Atomic Energy Authority, Wantage, Eng.). pp 172-4 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Indium and thallium were determined in zinc metal by neutron activation analysis. The indium content was found nondestructively via 54 min ^{116m}In measuring the 1.27-MeV photopeak by gamma spectrometry. The decay of this photopeak was also used as a further means of discrimination. The samples were subsequently reirradiated and the thallium content measured via radiochemical purification of ^{204}Tl, the purity of the radioactivity being confirmed by beta-absorption measurements and decay studies. The method was applied to the analysis of zinc doped with indium and thallium and the results compared with those obtained spectrographically and polarographically. The method was subsequently applied to the analysis of zinc metal and zinc salts. The interference of zinc in the gamma spectrometry of indium is discussed together with the effects of varying irradiation and decay times. (auth)

12311 FAST-NEUTRON ACTIVATION ANALYSIS SYSTEM WITH INDUSTRIAL APPLICATIONS. Wood, J. D. L. H. (Services Electronics Research Lab., Hertfordshire, Eng.); Downton, D. W.; Bakes, J. M. pp 175-81 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An activation analysis system is described which centers around a sealed-off neutron tube with an output of 10^{10} 14 MeV n/sec and employs fast pneumatic sample transfer and gamma spectrometry. Nuclides with half-lives in the range of a few seconds up to several hours may be employed in this system as neutron output is essentially constant for at least 100 hr. The concentration of oxygen in steel down to the 10 ppM level in 10 g samples was measured, and the suitability of the system for industrial use at the sampling rate of 600 samples per day is discussed. Concentrations of major mineral constituents were studied. Oxygen, silicon, and aluminum were determined to an accuracy of 2% in ½ g samples. The extension of the technique to other elements by purely instrumental methods without recourse to chemical separation is discussed. (auth)

12312 PLACE OF ACTIVATION ANALYSIS IN A RESEARCH ESTABLISHMENT DEALING WITH PURE MATERIALS. Smales, A. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 186-8 of Proceedings of 1965 International Conference on Mod-

ern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The advantages and disadvantages of activation analysis, as compared with other techniques for nonroutine analysis of pure materials, are evaluated. Criteria of sensitivity, specificity, contamination possibility, and accuracy of various techniques are considered. (J.G.B.)

12313 CsI–NaI DUAL-CRYSTAL COMPTON REDUCTION DETECTOR. Lam, Carroll F.; Wainerdi, Richard E. (Texas A and M Univ., College Station). pp 189-93 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The shapes of the pulses that result from the interaction of gamma rays in CsI(Tl) and NaI(Tl) detectors are sufficiently different to permit the separation of CsI pulses from NaI pulses by means of coincidence spectrometry. A detector and associated circuitry were developed that provide a degree of reduction in the Compton region of gamma spectra by means of a 3-in. × 3-in. NaI(Tl) primary detecting crystal surrounded by a 5-in. × 5-in. CsI(Tl) crystal. Both crystals are optically coupled to a single 5-in. photomultiplier tube. A coincidence pulse-shape based circuit controls a gating circuit in a multichannel analyzer. Operationally, pulses that result from gamma interactions in the NaI(Tl) only are counted while pulses that result from interactions in the NaI and CsI simultaneously, or in the CsI alone, are not counted. The resulting reduction in the Compton region is about 50% of the area of the Compton region. The amount of reduction increases linearly at points in the Compton region below the Compton edge. Spectra are presented which illustrate the effectiveness of the system for reducing the Compton region for single elements and for combinations of elements where the photopeak of one element lies within the Compton region of another element. (auth)

12314 THE EVALUATION OF COMPUTER PROGRAMS FOR GAMMA-RAY SPECTROMETRY IN ACTIVATION ANALYSIS. Emery, J. F.; Dyer, F. F.; Alexander, T.; Schonfeld, E. (Oak Ridge National Lab., Tenn.). pp 212-15 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Three operational computer programs for resolving gamma-ray spectral data were evaluated. Two of these programs use linear least-squares methods and the third, a nonlinear least-squares method for resolving the spectra. Some problems considered are ability to make gain-shift corrections, the effect of zero-activity nuclides on other nuclides present and the significance and reliability of computed "standard deviations." Results are presented for a series of samples with five replicates each analyzed by the three programs. Computer programs for resolving gamma spectra require a number of computer-control data such as peak channel, gamma energies, gain shift, etc. The number and complexity of this control information depend largely upon the versatility of the program and upon the purpose for which the program was designed. Each of these programs was evaluated for its simplicity of use with a large number of samples. The computer cost per analysis for each program was also determined. (auth)

12315 ACTIVATION ANALYSIS OF URINE FOR TRACE ELEMENTS. Bird, Edward D.; Ellis, William H.; Thomas, William C. Jr. (Univ. of Florida, Gainesville). pp 216-19 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

In vitro studies demonstrated inhibition of mineralization by a number of cations, zinc and manganese being the most potent. Activation analysis of urine from patients with kidney stones and normal subjects failed to demonstrate any difference in the urine concentration of zinc and manganese in these two groups. However, results indicated that the urinary zinc excretion depended on the volume output and was related to the urine calcium excretion. Further studies in patients with parathyroid disease confirmed the relation to calcium metabolism and suggested a possible homeostatic control for zinc in the body. Other divalent cations are being measured by activation analysis to determine if a similar relation exists. (auth)

12316 INTERFACING A TELETYPEWRITER TO NUCLEAR INSTRUMENTS USED FOR COMPUTER-COUPLED ACTIVATION ANALYSIS. Shideler, Ronald W. (National Bureau of Standards, Washington, D. C.). pp 236-42 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Techniques and actual designs involved in the interfacing of a teletype to a digital multichannel pulse-height analyzer and to an automatic sample changer are discussed. Two separate designs are discussed for interfacing to the multichannel analyzers. The first involves only minor changes to the analyzer. The second provides interfacing with no modification to the standard analyzer and includes the additional capability of reading precursor data from external units including a time-of-year clock and programmed data groups. These data are included in the output format along with the analyzer data and serve to identify the data as well as to instruct the computer in its subsequent analysis. A discussion of the merits and advantages in the use of the teletype machine as an input-output device is given. (auth)

12317 NEUTRON-ACTIVATION ANALYSIS OF ^{18}O WITH CHEMICAL SEPARATION. Ellis, W. H.; Fritz, G. J.; Han, I. G. (Univ. of Florida, Gainesville). pp 248-52 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An activation analysis method for the determination of ^{18}O was developed, which involves chemical separation prior to activation. The technique entails the separation of oxygen from other sample constituents by conversion of the oxygen into carbon dioxide and subsequently into solid ammonium carbamate prior to neutron irradiation. The conversion procedure affords an extremely high degree of decontamination of the oxygen and permits the determination of ^{18}O in the submicrogram range. The procedure was applied to determination of ^{18}O content of water samples prepared from enriched and normal water sources. The technique has considerable potential for use in the determination of ^{18}O used in tracer studies for chemical and biological systems. With further refinement the carbamate conversion method promises to become competitive with mass spectrometric techniques for ^{18}O determination. (auth)

12318 ACCURACY OF RADIOACTIVATION ANALYSIS. Cali, J. Paul (Air Force Cambridge Research Labs., L. G. Hanscom Field, Bedford, Mass.); Weiner, Joseph R.; Rocco, Gregory G. pp 253-8 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The accuracy of radioactivation analysis is subject to many systematic errors which may be grouped under these headings: factors related to chemical manipulations, irradiation, nuclear constants, counting, and others. Because an activation analysis can be performed in many ways, only four analytical methods are discussed. They are primarily four different ways of analyzing trace elements by gamma spectrometry. For each of these methods the random error of each of the factors discussed was evaluated as it may be applicable. Using a propagation of error treatment the total error to be expected for each of the four analytical methods was then estimated. The 2-σ range of error is from ±14 to 120%, and this may be taken as a reasonable limit of accuracy for radioactivation analysis subject to the limitations quoted. It was shown how experimental accuracy data obtained from the analysis of standard materials compares with predicted errors. (auth)

12319 COMPARISON OF NEUTRON-ACTIVATION ANALYSIS AND VACUUM-FUSION ANALYSIS OF THE OXYGEN CONTENT OF STEEL. Wood, D. E. (Kaman Aircraft Corp., Colorado Springs, Colo.); Pasztor, L. C. pp 259-64 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A system for the fast-neutron activation analysis of the oxygen content of metals was tested comparatively with the more conventional vacuum fusion techniques. The results of these tests indicate that neutron activation analysis is much faster (the total analysis takes only 2 min or less) and probably more reliable than the vacuum-fusion method because all oxygen present is analyzed. Samples can be much larger than the 0.2 to 3 gram samples used for the fusion method. Furthermore, the analysis is nondestructive, and the same samples can be reanalyzed as often as desired. The fast-neutron analysis system includes a 14-MeV neutron generator producing 10^{11} n/sec, a dual-tube pneumatic transfer system, a 5-in. × 5-in. NaI(Tl) crystal, a single-channel analyzer, two scalers, and timers, and switchgear. A sample in a polyethylene bottle and a Lucite reference are irradiated simultaneously after which the sample is returned to a scaler for counting the ^{16}N gammas from the $^{16}O(n,p)^{16}N$ reaction. The reference is then counted in a second scaler; the ratio of the sample counts to the reference counts is proportional to the oxygen content of the sample. The standard deviation in the neutron activation analysis tests was ~3%. A deviation of only 1% can be achieved in more refined systems. (auth)

12320 DETERMINATION OF SOME LIGHT ELEMENTS BY SECONDARY REACTIONS. Aumann, D. C.; Born, H. J. (Technische Hochschule, Munich). pp 265-71 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A short review is given of the sources of the secondary particles and of the advantages and disadvantages of the activation by secondary reactions. A method was developed for the determination of ^{18}O in hydrogen-containing substances by the secondary reaction $^{18}O(p,n)^{18}F$ induced by recoil protons. The reaction chain $^{6}Li(n,\alpha)^{3}H$, $^{16}O(t,n)^{18}F$ was made the basis of a method of detection of lithium in a variety of substances and of detection of oxygen in metal–organic compounds, organic solvents, and monomers. It is also shown that the matrix-effect, which appears in activation analysis with secondary reactions, can be compensated in most cases by calculated factors containing the different ranges of the charged particles and the different atomic densities of sample and standard. (auth)

12321 DETERMINATION OF BIOSPHERIC LEVELS OF ^{129}I BY NEUTRON-ACTIVATION ANALYSIS. Keisch, B.; Koch, R. C.; Levine, A. S. (Nuclear Science and Engineering Corp., Pittsburgh). pp 284-90 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Since ^{129}I is formed in atmospheric nuclear detonations, increases in its concentrations in environmental and biological matrices would be expected following world-wide deposition of debris from these detonations. Its concentrations in thyroid tissues and related commercial preparations were selected to serve as an index of the biospheric levels of ^{129}I. An array of several hundred samples was studied. The general experimental method involved preirradiation purification of the iodine fraction of the sample as well as postirradiation radiochemical purification operations. A beta–gamma coincidence counter was used. Several significant modifications were incorporated in the detector–instrumentation system and in the experimental procedures, which resulted in increased analytical sensitivity and accuracy. ^{129}I levels were determined in thyroid tissues from subjects spanning the entire age group (pediatric to geriatric). A statistically significant variation of the $^{129}I/^{127}I$ ratio with age was observed in recently collected samples (1962 to 1964) from young subjects. The ratio was largest in pediatric tissues and decreased by about a factor of four with age through adolescence and early adulthood. In more advanced age groups the ratio was essentially constant about a mean value of $(1.45 \pm 0.40) \times 10^{-9}$. These samples were collected in Pittsburgh, Pennsylvania, and New York City. No significant geographical or temporal differences were observed. However, studies of biological material collected at various times since 1945 at various locations revealed a distinct temporal behavior for the $^{129}I/^{127}I$ ratio. The samples collected from approximately 1949 to 1952 exhibited maximum values that exceeded current values by more than two orders of magnitude. The predicted value (10^{-14}) for the preatomic era $^{129}I/^{127}I$ ratio was not detected, but analysis of pre-1945 iodine-bearing chemical compounds established a value of $\sim 3 \times 10^{-12}$ for the ratio. This value corresponds closely to the expected limit imposed on the method of analysis by multiple neutron capture in ^{127}I during neutron activation. (auth)

12322 NEW DEVELOPMENTS IN THE SYSTEMATIC ANALYSIS OF HIGH PURITY METALS AND ESPECIALLY OF ALUMINUM, COPPER AND ZIRCONIUM. Albert, P.; Cuypers, M.; Lesbats, A.; Mignonsin, E. (Centre d'Etudes de Chimie Metallurgique, CNRS, Vitry, France). pp 310-15 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The systematic analysis of copper was developed using separations by electrolysis under controlled potential. The determination of sulfur was performed by different methods, depending on the relative concentration of this element and the phosphorus content in the copper samples. A great number of analyses were performed by this method on samples, and the total impurity concentrations which were determined varied from 0.6 to 25 ppM. A method of systematic analysis of zirconium, based on the initial separations by ion exchange with an anion resin of the impurities in eight groups, was studied. The advantage of this method was that the sample can be dissolved in a hydrofluoric–nitric medium, avoiding the principal disadvantages of the use of hydrofluoric acid. The determination of sulfur and phosphorus are possible in the systematic analysis. The systematic analysis of aluminum was improved at different points. One of the results of the study of the analysis of copper was the development of a scheme of separations of the radioisotopes of the elements that sulfides precipitate in an acid medium. These separations are now used on a routine basis in the systematic analysis of aluminum, iron, and zirconium. (auth)

12323 SIMPLE AND RAPID MAGNESIUM DETERMINATION IN BIOLOGICAL SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Kim, Chong K.; Meinke, W. Wayne (Univ. of Michigan, Ann Arbor). pp 316-18 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Activation analysis of magnesium using the 9.5-min ^{27}Mg is described. The method can be successfully applied to any biological sample, giving good results within a few minutes. Samples analyzed included whole blood, drinking water, urine, and beef tissue. (auth)

12324 USE OF NEUTRON ACTIVATION ANALYSIS TO DETERMINE BIOLOGICAL AVAILABILITY OF COPPER IN SOILS AND FOR NONDESTRUCTIVE ANALYSIS OF SOILS. Kline, J. R.; Brar, S. S.; Gustafson, P. F.; Rust, R. H. (Argonne National Lab., Ill. Univ. of Minnesota, St. Paul). pp 319-23 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Methods were developed for determination of various chemical fractions of copper in soil samples by a batch processing technique, which allows the collection of a reasonable body of information in relatively short time intervals. Information, which was obtained by application of these methods includes measurement of the kinetics and amounts of copper released from several soils. Other fractions of soil copper obtained include that which is contained in dilute acid soluble minerals and that which is contained in the very stable silicate structures of soils. In other observations of neutron irradiated soils little of biological interest was found by observing the gamma spectra of chemically unaltered soils. The spectra did show a surprising degree of structural uniformity, however, which was not anticipated since the samples were originally taken from widely separated areas of Minnesota and from areas that differed in the geologic mode of deposition. The similarities of the spectra suggest certain limitations on the use of gamma spectra of neutron-irradiated soils for identification of soils or the tracing of specimens to their origin. (auth)

12325 NEUTRON ACTIVATION ANALYSIS FOR PLUTONIUM MIXED IN SOIL. Fuller, R. K. (Naval Radiological Defense Lab., San Francisco); O'Connor, J. D.; Lukens, H. R.; Fleishman, D. pp 324-6 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A nondestructive, quantitative, analytical procedure was developed for determining plutonium mixed in soil. The method is entirely instrumental and can probably be used to analyze for plutonium in other materials. The procedure eliminates the need for chemical separations and for alpha counting. It also eliminates the need to know the age and composition of the original source of plutonium or to have a reference sample of it. The neutron activation procedure was developed to analyze for plutonium in samples of particulate fallout material deposited from dust clouds generated by high explosive, nonnuclear detonations of simulated nuclear weapons containing plutonium and depleted uranium (containing 0.2% ^{235}U). The samples were collected on horizontal, petrolatum-coated, 16 sq ft aluminum collectors located at ground level positions, downwind from the detonation. Samples consisted of particles of plutonium and depleted uranium from the device, mixed with desert soil, which itself had a background of natural uranium (containing 0.72% ^{235}U) but no plutonium. Essentially the method consisted of determining the intensity of the 105-keV photopeak of 2.33-day ^{239}Np and the 1.60-MeV photopeak of 40.2-hr ^{140}La in neutron-irradiated fallout samples, in calibration standards, and in pre-shot desert background soils. The major radioactive isotopes produced in the soil matrix of the fallout samples of neutron irradiation were 2.3-min ^{28}Al, 8.7-min ^{49}Ca, 2.58-hr ^{56}Mn and 15-hr ^{24}Na. Of these, only ^{24}Na made a significant contribution to the gamma radiation rate at 2 to 6 days. After 6 days there was no significant gamma radiation from soil, except from uranium. ^{24}Na has photopeaks only at 1.37-MeV and 2.7-MeV; thus, it did not contribute significantly to the intensities of either the 105-keV or the 1.6-MeV photopeaks. (D.H.M.)

12326 ELECTRON ACTIVATION ANALYSIS FOR THE DETERMINATION OF CARBON IN SUBMICROGRAM QUANTITIES OF VIRUS. Kruger, Paul; Linstedt, K. D. (Stanford Univ., Calif.). pp 327-30 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An analytical method is being developed for physical measurement of submicrogram virus samples to complement the usual means of electron microscopy and biological plaque counting. For this method, the Stanford University Mark II electron linear accelerator is used to produce 35-MeV electrons for irradiation of tobacco mosaic virus targets. The analysis involves the measurement of the macro-constituent, carbon, which determines the virus content. (auth)

12327 ACTIVATION WITH PHOTONS OR CHARGED PARTICLES FOR THE ANALYSIS OF NONMETALLIC ELEMENTS. Engelmann, C.; Cabane, G. (CEN, Saclay, France). pp 331-6

of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Methods of activation were sought, which might produce usable isotopes with elements such as oxygen, carbon, nitrogen, phosphorus, etc. The methods had to be sensitive to concentrations as low as 1 ppM, and the activation ought to be so specific that no dissolution and chemical separation would be needed. A prospect of the nuclear reactions that might be produced by photons or charged particles, suitably accelerated, shows possibilities for this kind of activation analysis. More precisely, the following were used: a linear accelerator giving electrons up to 40 MeV and producing α rays by the slowing down of these electrons in a platinum target; a cyclotron accelerating α particles to 44 MeV; another cyclotron, built by Philips, which produces an external beam of protons whose energies may be adjusted from 3 to 30 MeV. The first two accelerators were connected to the counting room by rabbits, so that the personnel were not irradiated by coming too close to the accelerator and activities of half-lives no longer than 2 min were easily registered. Present research is based on: control, several thousands of analyses of impurities (mainly, oxygen, carbon and nitrogen) in zone-refined beryllium, and some other nuclear materials, and research, activating standards at various energy levels to determine the conditions of specific activation of given impurities and finding a new method to calculate the volume activated by charged particles whose nuclear cross section varies as they slow down in very small thicknesses. The studies allowed many determinations of trace amounts of oxygen, carbon, nitrogen, and fluorine in nuclear materials; the conditions for the analysis of boron, phosphorus, and sulfur were determined; these analyses are usually nondestructive and their sensitivities are better than 10^{-7} g; in some specific cases they can detect less than 10^{-9} g. (auth)

12328 ON THE USE OF AN AUTOMATIC CHEMICAL TREATMENT SYSTEM IN ACTIVATION ANALYSIS OF BIOLOGICAL SAMPLES. Comar, D.; Le Poec, C. (Commissariat a l'Energie Atomique, Orsay, France). pp 351-6 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An entirely automated and continuous system for the chemical separation of inorganic elements, especially sodium and chlorine, from liquid biological samples was perfected for the determination of iodine. The process of the chemical treatment is as follows: separation of sodium and proteins by anionic resin filtration, differential elution of halogens, solvent extraction of iodine, distillation, and β-counting of the purified sample. Technical devices and performances of the apparatus are discussed. Its potential use in the determination of other elements is considered. (auth)

12329 MINOR CONSTITUENTS DETERMINATION IN COMPLEX MATERIALS BY ACTIVATION ANALYSIS WITH ISOTOPIC DOUBLE DILUTION FOR REMOVING THE ERRORS DUE TO SELF-SHIELDING, ENHANCEMENT AND NEUTRON RESONANCE. Cappadona, Carmelo (Univ., Palermo, Italy). pp 363-4 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Activation analysis allows rapid determination, and is competitive with other methods, for elements occurring in concentrations of 0.01% up to a few percent in complex materials such as animal and vegetable tissues, some alloys, soils and fertilizers, flours, mineral and sea water, etc. As big reactors are few and dispersed, it is preferable to use the small reactors and generators. The sensitivity of the method is not sufficient for the determination of trace amounts in every case; thus, for the best use of the apparatus it is necessary to determine minor constituents. A wide range of application is possible in the analysis of complex substances for minor constituents (occurring in order of milligrams in irradiated samples) that give rise to radioisotopes having a half-life long enough to permit chemical separations. For this purpose a particular method is suggested which allows sample irradiation without standard and offers the great advantage of removing errors due to self-shielding, or enhancement, or neutron resonance. (auth)

12330 OXYGEN DETERMINATION USING TRITON ACTIVATION. De Goeij, J. J. M.; Houtman, J. P. W. (Reactor Inst., Delft, Netherlands). pp 372-9 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The use of the $^{16}O(t,n)^{18}F$ reaction for the determination of oxygen was investigated. The limited depth of penetration of tritons, which were formed during irradiation in the reactor from the lithium added to the sample by the (n,α) reaction, made the determination of oxygen concentrations in surface layers possible. Examples of the need for this type of determination can be found in metallurgy, where the thickness and composition of oxide layers are not always easily measured in other ways, or where a boundary layer with different oxygen content as a result of oxygen diffusion can influence certain properties of the metals. Other possible applications can be found in the investigation of plastic film, particularly of their surface oxidation or the extent of diffusion of oxygen-containing plasticizers. Factors influencing the sensitivity and accuracy of the determination are: the stopping power for tritons of the materials in which the oxygen is to be determined; the homogeneity and reproducibility of the triton flux; the recoil of the ^{18}F formed; the natural oxygen content of the lithium compound; the contact area between lithium and oxygen-containing compounds; and interferences with other reactions. Attention was focused on the analysis of foils, covered with lithium-containing films, and powders in a mechanical mixture with a lithium compound. (D.H.M.)

12331 METHODS OF ACTIVATION ANALYSIS FOR MERCURY IN THE BIOSPHERE AND IN FOODS. Christell, R.; Erwall, L. G.; Ljunggren, K.; Sjostrand, B.; Westermark, T. (Royal Inst. of Tech., Stockholm). pp 380-2 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Samples from virtually the whole biosphere were collected and are being analyzed together with several foodstuffs for mercury. Activation analysis is important in this context because sensitivities below the provisional WHO-FAO limit at 50 ng/g are easily achieved. (auth)

12332 INDICATION OF OXIDE AND HYDRIDE CONTENT IN MELTED SODIUM BY MEASURING ELECTRICAL RESISTIVITY. Subbotin, V. I.; Ivanovskii, M. N.; Arnoldov, M. N.; Shmatko, B. A.; Pleshivtsev, A. D. At. Energ. (USSR), 21: 511-12(Dec. 1966). (In Russian).

The content of liquid sodium used as reactor coolant must be carefully controlled in order to ensure reliable operation of the system. It was suggested previously that the dissolved gaseous impurities may be determined by changes induced in the physical properties, such as electric resistivity. In a paper by U. S. authors, automatic recording of the resistivity revealed no correlation between this property of liquid sodium or NaK and the amount of dissolved hydrogen or oxygen, although Soviet authors reported a definite dependence. In order to clarify this contradiction, the specific resistivity of sodium was determined at 350°C as a function of its oxygen and hydrogen content, using a double dc bridge for the measurement. The gases were introduced directly into the liquid metal and determined by pressure measurements. The liquid metal contained some additional oxygen in the form of sodium peroxide. In agreement with the data reported by K. Claxton, introduction of oxygen did not affect the resistivity; on the other hand, the presence of dissolved hydrogen increased the resistivity. Amounts of 3×10^{-4} wt % hydrogen could be detected with good sensitivity. (TTT)

12333 A METHOD FOR THE SIMULTANEOUS LIQUID SCINTILLATION COUNTING OF ^{55}Fe AND ^{59}Fe IN BLOOD SAMPLES. Lockner, D. (Karolinska Inst., Stockholm). Scand. J. Clin. Lab. Invest., 17: 247-52(1965).

A method is presented which allows measurement of ^{55}Fe alone or in mixture with ^{59}Fe, in blood or plasma samples, without any sample preparation. This method is of value because the simultaneous use of two radioisotopes of iron offers a means to study iron metabolism. In the described method, the samples are directly pipetted on to discs of filter paper which, after drying are counted in a liquid scintillation counter. Stable readings were obtained when measurement was started 3 hr after inserting the sample. It was found that incomplete dryness of the samples introduced errors. This was pronounced with ^{55}Fe, as the weak radiation of this isotope is very easily absorbed. A counting efficiency of 12.8% ^{55}Fe and 100% ^{59}Fe, for plasma and an efficiency of 3% and 42.9% for blood were obtained. This counting efficiency for ^{55}Fe in plasma samples is much higher than by previous methods. The accuracy of this method is lower than earlier methods, but is sufficient for biological purposes. (TCO)

12334 AMPEROMETRIC ANALYSIS OF URANIUM(VI) SOLUTIONS. Strafelda, F.; Vondrak, D. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun., 31: 4635-43(Dec. 1966). (In German).

A method for amperometric determination of UO_2^{2+} in 1×10^{-3} M H_2SO_4 + 0.05M Na_2SO_4 (pH ≈ 3.2) in the presence of VO_3^-, Fe^{3+}, Cu^{2+}, and other components of the acid decomposition of uranium ores was developed. The cathodic reduction of UO_2^{2+} on a rotating platinum ring electrode was accompanied by a wave with a half-wave potential of −0.25V. The wave height is proportional to the UO_2^{2+} concentration up to 8×10^{-4}M. The waves of VO_3^- and Fe^{3+} appear before the UO_2^{2+} wave and do not disturb it; interfering Cu^{2+} ions can be masked with complexone III. (tr-auth)

12335 DETERMINATION OF A LABELLED TRITIUM COMPOUND IN BLOOD BY A 2π GAS FLOW COUNTER. Ito, Shigemitsu (Univ. of Nagoya, Japan). Radioisotopes (Tokyo), 14: 525-33(Nov. 1965). (In Japanese).

A reproducible, infinite thickness sample specimen can be obtained by heating a 0.5 to 1.0 ml sample solution (plasma and serum) diluted 10-fold with 0.9% saline. The efficiency is approximately 2.5%. When diluted with saline for the self-absorption, 0.9% saline must be estimated as approximately 0.64 mg/ml after dried. The errors are caused mainly by the charge effect and by the insufficient filling of the counter with gas. These errors can be detected either by using a pair of samples or by repeating the measurement. When measured values show a decreasing tendency after checking the apparatus, the measurement must be repeated. In the case of increasing tendency, those values before attaining a peak value should be discarded and the values after this peak are taken for the calculation. The corrected values tend to shift to the higher values. The method is applicable to various biological measurements. (auth)

12336 SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTH ELEMENTS WITH ERIOCHROME BLACK T. Takano, Tsuneo (Ibaraki Univ., Japan). Bunseki Kagaku, 16: 27-30(Jan. 1967). (In Japanese).

Methods are described for the spectrophotometric determination of lanthanum, neodymium, gadolinium, erbium, and ytterbium with Eriochrome Black T. The sample solution containing 5 to 80 μg of rare earth element was transferred to a 25 ml volumetric flask. Eriochrome Black T was added and pH was adjusted to 9 by a buffer solution of ammonium chloride and ammonium hydroxide. Potassium cyanide was added to eliminate the interference of many elements in the sample solution. After diluting to the mark and allowing to stand for 15 min, the absorbance was measured in a 10 mm cell at 640 mμ (indirect method) or 510 mμ (direct method). Beer's law was obeyed in the concentration range of 0 to 90 μg rare earth element per 25 ml. (auth)

12337 DIFFERENTIAL COUNTING OF TRITIUM AND ^{14}C IN URINE AND BLOOD SERUM BY LIQUID SCINTILLATION METHOD. Kang, Man Sik; Chung, Hack Pil. Kisul Yon Guso Pogo, 4: 42-5(1965).

The simultaneous equation method for differential counting of tritium and carbon-14 in human urine and blood serum was studied by means of liquid scintillation. The liquid scintillator was made by dissolving 4 g of 2,5-diphenyl oxazole and 0.1 g of 2,2'-p-phenylenebis[5-phenyl] oxazole in 1 l of toluene. It was concluded that the method is practical for counting tritium and carbon-14 activity in human urine and blood serum. (auth)

12338 COLORIMETRIC METHOD FOR DETERMINATION OF CERIUM USING N,N'-DI(β-HYDROXYPROPYL)-o-PHENYLENEDIAMINE. Kasterka, Barbara; Ostrowski, Stanislaw (Faculty of Pharmacy, Academy of Medicine, Danzig). Chem. Anal. (Warsaw), 11: 1135-40(1966). (In German).

A method was developed based on the measurement of absorbency of the color product of oxidation of N,N'-di-β-hydroxypropyl-o-phenylenediamine with cerium(IV). Maximum absorption was observed at 525 nm. Specific absorptivity at this wavelength, using a slit 0.01 mm wide, was 53×10^3 cm$^2 \cdot$ g^{-1}. The system used obeyed Beer's law in the concentration range up to 20 μg Ce/ml. Temperatures between 17 and 24°C and excess reagent added for times up to 3 hr had no effect on the intensity of the coloration. Ions having oxidative or reducing properties such as Fe^{3+}, Cu^{2+}, Ag^{+}, Hg^{2+} and Sb^{3+} interfered with the determination. Ni^{2+} caused negative errors. The calibration curve was set up and the method was applied for determination of cerium in two specimens of bottom sediments from Baltic Sea. The determinations were carried out after separation of cerium as oxalate using calcium oxalate as carrier. (auth)

12339 SPECTROPHOTOMETRIC STUDIES OF COMPLEXES OF RARE EARTH ELEMENTS AND THYMOLPHTHALEXON. I. APPLICATION OF THYMOLPHTHALEXON FOR DETERMINATION OF RARE EARTH ELEMENTS. Prajsnar, Danuta (Politechnika, Gliwice, Poland). Chem. Anal. (Warsaw), 11: 1111-16(1966). (In Polish).

Complexes of thymolphthalexon (TMP) with Pr^{3+}, Nd^{3+}, Sm^{3+}, Gd^{3+}, Ho^{3+} and Yb^{3+} were studied spectrophotometrically. Absorption curves of these complexes had similar patterns and had well-defined absorption maxima at 592 to 594 nm. Measurements in this range were used for determination of separated rare earth elements. The measurements were carried out at pH 9.5 to 11.0. The Lambert-Beer law was obeyed for the rare earth element concentration range from 0.5 to 4.5 μg/ml, at TMP concentration of 40 μg/ml. Absorbencies of the TMP complexes are constant over a period of several hours. Higher concentrations of certain anions interfere (e.g., PO_4^{3-}, $C_2O_4^{2-}$, citrate above 100 μg/ml, iminediacetate above 25 μg/ml, EDTA – 1 μg/ml). (auth)

12340 IMPROVED METHOD FOR THE CONSTANT-CURRENT POTENTIOMETRIC DETERMINATION OF PLUTONIUM. Pietri, Charles E.; Wenzel, Albert W. (Atomic Energy Commission, New Brunswick, N. J.). Talanta, 14: 215-18(Feb. 1967).

A highly precise method is described for the determination of plutonium by constant current potentiometric titration with primary standard potassium dichromate. The relative standard deviation was 0.04% or better. (auth)

12341 PRECISE DETERMINATION OF URANIUM IN PURE URANIUM AND URANIUM COMPOUNDS BY CONSTANT-CURRENT COULOMETRIC TITRATION. Malinowski, Jerzy (International Atomic Energy Agency, Seibersdorf, Austria). Talanta, 14: 263-5(Feb. 1967).

A procedure is described for very precise determination of uranium in high-purity uranium and uranium compounds. Uranium(VI) was reduced in a concentrated hydrochloric acid solution by metallic aluminum in the presence of cadmium ions to uranium(III). This was oxidized to uranium(IV) by protons on addition of an excess of orthophosphoric acid, and then oxidized to uranium(VI) by adding a weighed quantity of potassium dichromate in small excess. The excess of potassium dichromate was determined by constant-current coulometry. The coefficient of variation did not exceed 0.003%. (auth)

12342 EXPERIMENTAL EVALUATION OF NEUTRON ACTIVATION, WET ASSAY, AND FIRE ASSAY METHODS OF DETERMINING GOLD IN ORES. Chow, A.; Beamish, F. E. (Univ. of Toronto). Talanta, 14: 219-31(Feb. 1967).

Errors associated with fire-assay, wet-extraction, and neutron-activation methods were evaluated; the accuracy and precision of these methods were compared and a method of determining chemical recovery in the activation determination of gold in ores and concentrates is presented. (auth)

12343 USE OF THENOYLTRIFLUOROACETONE FOR THE DETERMINATION OF MANGANESE BY ACTIVATION ANALYSIS. Kukula, Frantisek; Mudrova, Blazena; Krivanek, Miloslav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Talanta, 14: 233-7(Feb. 1967).

A procedure for the substoichiometric extraction of bivalent manganese by thenoyltrifluoroacetone into ethyl acetate was developed and used in activation analysis. The value of the extraction constant was found to be 3.1×10^{-6}; the pH range in which the extraction can be performed was 7.8 to 9.2. The influence of oxalate, citrate, tartrate, fluoride, and cyanide ions was studied. A selective substoichiometric extraction of manganese in the presence of Zr, Hf, Nb, Th, Fe, and Sc was possible at pH 8 to 8.5, tartrate and fluoride being used as masking agents. Copper and cobalt can be screened by ammonia and cyanide respectively. The method was used for the determination of manganese in biological materials, potassium fluoride, and zirconium. (auth)

12344 DETERMINATION OF THE ABUNDANCE RATIO OF COPPER ISOTOPES BY A SURFACE IONIZATION METHOD. Kanzaki, Tadao; Yokozuka, Seiichiro; Kakihana, Hidetake (Tokyo Inst. of Tech.). Bunseki Kagaku, 16: 7-15(Jan. 1967). (In Japanese).

A surface ionization method was applied to the determination of the abundance ratio of copper isotopes. The single-collector method was proven better than the double-collector method. The experimental conclusions on the single-collector method were: the accuracy was ±0.5% (standard deviation), copper nitrate $\{Cu(NO_3)_2\}$ sample gave better results than copper chloride ($CuCl_2$); the combination of a rhenium ionization filament and a tungsten vaporization filament gave the best results among the other double or single filament arrangements, the $^{63}Cu^{+}$ ion current, the currents of ionization filament and vaporization filament, and the time from the initiation of heating of the filament to the measurement of ion-peak ($^{63}Cu^{+}$, $^{65}Cu^{+}$) should be held constant in a series of experiments; the same ionization case should be used to compare the abundance ratio of copper isotopes. The time required for a measurement was about 2 hr. (auth)

12345 ANALYSIS OF NUCLEAR FUEL ELEMENTS. III. SEPARATION OF SOME URANIUM FISSION PRODUCTS BY PAPER CHROMATOGRAPHY. Getoff, N.; Bildstein, H.; Pfeifer, V.; Sorantin, H.; Titze, H. (Reactor Center, Seibersdorf, Austria). Atompraxis, 12: 563-7(Nov. 1966).

The separation of the fission products and uranium was studied by one- and also by two-dimensional paper chromatography. Investigations were carried out using artificial mixtures of selected nuclides as well as by neutron irradiation of uranium. Under the conditions studied it was possible to separate the rare earth elements only as a group from the rest of the fission products. Individual separations were achieved for the nuclides: ^{90}Sr, ^{90}Y, ^{95}Nb, ^{95}Zr, ^{137}Cs, ^{140}Ba, and uranium. (auth)

12346 THE METHOD OF RADIOACTIVE INDICATORS: PRINCIPLE, ADVANTAGES, AND LIMITS. Lerch, P. (Univ., Lausanne, Switzerland). Chimia (Aaru), 21: 1-8(Jan. 16, 1967). (In French).

The indispensable conditions for the success of the tracer method are discussed; the various ways of labeling are presented and compared. The existence of isotopic effects constitutes a fundamental limitation of the radioactive tracer method, which may be capable of compromising its results. The physical isotopic effects are first explained; the different categories of chemical isotopic effects are then described; and their incidence in radiochemistry is examined. The radiolytic action of radiation emitted by the radiotracers represents a second fundamental limitation to be considered by the radiochemist; the chemical transformations of the labeled molecules, which occur at the very moment of disintegration, constitute a third, not always negligible limitation; these phenomena are described and their importance evaluated. Several experimental contingencies may also play a part in limiting the use of the radioactive tracer method; it is often essential to have available radioisotopes of high specific activity; the radioisotopic, radiochemical, and chemical purity of the radioactive substances exercise an important influence. The choice of radioisotope (half-life, nature and energy of the radiation emitted), when this is possible, can have a decisive influence on the success of the tracer method. Finally, the problem of radiation protection of the operators and the imperatives prescribed by it is touched on. (auth)

12347 METHOD OF ISOTOPE DILUTION. Broda, E. (Univ., Vienna). Chimia (Aaru), 21: 8-15(Jan. 16, 1967). (In German).

The principle and history of the isotope dilution method are discussed. The use of "inverse isotope dilution method" in trace analysis is described. A combination of isotope dilution and radioreagent method is used when the substance to be determined is labeled at a later stage by a reaction with radioisotopes. (D.H.M.)

12348 ANALYSIS WITH RADIOACTIVE REAGENTS AND RADIOMETRIC TITRATION. Braun, T. (Univ. L. Eoetvoes, Budapest). Chimia (Aaru), 21: 16-26(Jan. 16, 1967). (In German).

Examples are given in the fields of radioreagent methods based on solid-liquid, gas-liquid, and liquid-liquid phase separation. The possibilities for a radiometric end-point detection are discussed. Titrations based on precipitation formation with solid–liquid separation as well as titrations based on complex formation with liquid–liquid separation are mentioned. Radiometric titrations using solid indicators, radioactive amalgams, and radioactive metals are discussed. (D.H.M.)

12349 INVESTIGATION OF FACTORS AFFECTING THE ACCURACY AND SENSITIVITY OF THE FLUOROMETRIC DETERMINATION OF URANIUM. Samsoni, Zoltan (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Mikrochim. Acta, No. 1, 88-97(1967).

Investigations were made on the influence of melt-bead composition, quantity, period, and temperature of heating, and conditions of cooling on the intensity of fluorescence produced and on the stability of fluorescence intensity with time. The optimum parameters were found to be as follows: basic bead material, 50 mg of a mixture of 30% of NaF and 70% of $NaKCO_3$; a heating temperature 650°C in an electric oven for 10 min followed by slow cooling in the switched-off oven; after 2.5 hours the sample is removed from the oven (at about 280°C) and analyzed in the next 2 hours. The preparation exhibits roughly the same fluorescence for 24 hours, followed by a slow decrease in fluorescence. The measuring accuracy of the photomultiplier fluorimeter was improved by means of a filter of 1% tartrazine solution. (auth)

12350 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF THE URANYL ION WITH 4-(2-THIAZOLYLAZO) RESORCINOL. Sommer, L. (Purkyne Univ., Brno); Ivanov, V. M. Talanta, 14: 171-85(Feb. 1967).

The uranyl ion formed only 1:1 chelates with 4-(2-thiazolylazo) resorcinol (TAR) in solution; $UO_2(TAR)H^+$ was formed below pH 3 and $UO_2(TAR)$ above pH 3.5. The latter complex was also precipitated at pH > 3. The quantitative formation of $UO_2(TAR)$ at pH 7.5 to 7.8 in solutions containing a small excess of reagent and some triethanolamine as buffer was used for the sensitive spectrophotometric determination of uranium. Several interfering ions were masked with a mixture of sodium fluoride, cyclohexanediaminetetraacetic acid and 5-sulphosalicylic acid. TAR was slightly less sensitive than 4-(2-pyridylazo)resorcinol as a reagent for uranium, but was more selective. (auth)

12351 A SURFACE METHOD OF MEASURING THE WATER EQUIVALENT OF SNOW BY MEANS OF SOIL RADIOACTIVITY. Zotimov, N. V. Soviet Hydrol., No. 6, 237-47(1965).

A method using the natural radioactivity of the ground for measurements of the water equivalent of snow and of some other hydrometeorological elements is based on the attenuation of soil radiation by the snow. The results of measurements made with instruments employing artificial radiation sources demonstrated the feasibility of employing the natural radioactivity of the soil to make surface measurements of the water equivalent of snow. The relation between soil background and soil moisture may be employed for measurements of the amount of moisture in various layers of the soil. The accuracy with which the water equivalent of snow is determined is affected by soil moisture, rainfall, tillage, and certain other factors. The average error in determination of the water equivalent of snow due to alterations of soil moisture may be 10 mm. The effect of rainfall and tillage may be excluded, and that of soil moisture minimized by selection of appropriate conditions for the measurement of the background. The background count was reduced by 13% on the average (range 2 to 20%) after tillage. The comparatively large scatter in variations of the background on different types of field was due to differences of soil composition, soil moisture, and the condition of the soil surface before tillage. The magnitude of the background before plowing was usually high on sectors with identical soils situated higher up the same slope than on sectors in hollows where the moisture content of the soil was high. One cause of reduction of the background following tillage apparently was an alteration of Rn content. Since less moist soils contained more soil air, their relative Rn-content was greater than that of moist soils. The relative exchange between soil air and the atmosphere therefore differed in the working of soils with different pore structures. (BBB)

12352 DETERMINATION OF SOME TRACE ELEMENTS IN HUMAN SERUM–ALBUMIN BY NEUTRON-ACTIVATION ANALYSIS. Malvano, R.; Rosa, U.; Grosso, P. (SORIN, Saluggia, Italy). Int. J. Appl. Radiat. Isotop., 18: 121-5(1967).

Neutron activation methods were applied to the determination of some trace elements (Ag, Co, Cr, Cu, Fe, Hg, Mn, Ni, Sb, Sc, and Zn) in selected specimens of human serum–albumin. The main impurities were found to be Cu, Fe, and Zn, which range from 5 to 150 ppM, while much lower concentrations were revealed for the other trace elements (2×10^{-4} to 2 ppM). A comparison between the neutron activation analytical results and data from—SH group titrations (amperometric methods) led to exclusion of any direct blocking effect on the—SH groups by heavy metals such as Ag and Hg, although some role of metal traces in the—SH group abolishment may be supposed. The separation procedure of the albumin from the plasma, as well as pasteurization treatments, did not seem to affect the metal contamination level, since a rough agreement with the normal values in plasma was found, and negligible differences between a pasteurized and an untreated aliquot from the same lot were found. (auth)

12353 PRECISE AND ACCURATE OXYGEN DETERMINATION BY FAST-NEUTRON ACTIVATION. Volborth, Alexis (Univ. of Nevada, Reno). Fortschr. Mineral., 43: 10-21(Apr. 1966).

Methodology, instrumentation, and results are given for a procedure whereby oxygen is determined in SiO_2, natural quartz, Al_2O_3, and $CaCO_3$ by activating it with 14-MeV neutrons. Accurate results were obtained using a dual self-correcting transfer and detection system designed to minimize the effects of beam instability of the neutron generator, aging and spottiness of the tritiated target, and drift in the electronics. A mechanism was devised that permitted the samples to travel alternate tubes and to be irradiated and counted at alternate sites consecutively. Two such irradiations and counts constituted a complete cycle. True oxygen ratio in different samples was obtained without plotting a calibration curve. An operational day-by-day precision of 1 to 2% in relative standard deviation was achieved, based on a minimum of 4 determinations. The accuracy obtained, expressed in relative standard deviation from the theoretical oxygen percentage of the oxides studied, and based on a minimum of 8 to 10 single determinations, varied from 0.03 to 0.33%. When based on a minimum of 20 to 32 determinations, results fell within 0.10% of the theoretical percentage in samples containing about 50% oxygen. Relative error varied from 0.3 to 0.7%, based on 8 to 32 determinations. (BBB)

12354 ANALYSIS OF NUCLEAR FUEL ELEMENTS. II. SEPARATION OF URANIUM FROM ALUMINIUM AND OF ^{140}Ba FROM URANIUM AND FISSION PRODUCTS BY ION EXCHANGERS. Titze, H.; Bildstein, H.; Getoff, N.; Sorantin, H.; Pfeifer, V. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). Atompraxis, 12: 509-12(Oct. 1966). (In German).

Two analytical methods using ion exchangers are described. The first method allows the separation of uranium from aluminium in 6N HCl using a strongly basic anion exchange resin (Dowex 1 × 8). Thereby uranium in an amount of 20 mg can be separated from 25-fold aluminium quantity. The determination of uranium is performed by titration with 0.01 N ceric sulfate with a standard de-

viation of 0.32%. The second method allows a routine separation and determination of Ba-140 in uranium fuel elements. Barium is first precipitated with other fission products as sulfate, then dissolved in EDTA and purified by cation exchangers. The method was tested with samples of known composition as well as with irradiated fuel elements. (auth)

12355 ASSAY OF ^{45}Ca IN BIOLOGICAL MATERIALS BY LIQUID SCINTILLATION COUNTING. Hutchinson, F. (Regional Physics Dept., Dundee, Scotland). Int. J. Appl. Radiat. Isotop., 18: 136-7(Feb. 1967).

A procedure involving deposition of the material on glass fiber paper, followed by immersion of the paper in the scintillator, is described. Glass fiber paper was chosen for the supporting medium as it increased counting efficiency by 90% as compared with chromatographic paper, and sample dilution was the only sample preparation operation required for fluids. Readings for urine and plasma samples agreed to within 3%. Application to both liquid samples and stool digests is described. Stool digests still required oxalate precipitation prior to estimation. The main limitation was the self absorption effect due to variation in the dried sample constituents. This effect cannot be estimated by external standardization techniques, but may be reduced to acceptable limits using sample dilution, or estimated using an internal standard. (UK)

12356 PHOTOACTIVATION OF GERMANIUM AND ITS APPLICATION TO THE DETERMINATION OF GERMANIUM IN IRON. Abe, Shigeki (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 88: 52-6(Jan. 1967). (In Japanese).

Based on the results of photoactivation of germanium, a method for nondestructive determination of germanium in iron was developed. Germanium oxide was irradiated for an hour with 20 MeV bremsstrahlung generated from the linear electron accelerator. The γ spectrum of photoactivated germanium showed a prominent photopeak of ^{75}Ge at 0.26 MeV and those of ^{69}Ge at 0.51, 0.88, 1.12, and 1.34 MeV. These photopeaks decayed with the half-lives of 82 min and 40.4 hr for ^{75}Ge and ^{69}Ge, respectively. Both ^{69}Ge and ^{75}Ge were produced by (γ,n) reaction of germanium. For the determination of germanium in iron oxide, the ^{56}Mn activity, which was produced by (γ,p) reaction of iron, was used as the internal monitor of photon flux intensity. The photopeak activity ratios of ^{69}Ge(0.51 MeV)/^{56}Mn(0.85 MeV) and ^{69}Ge(1.12 MeV)/^{56}Mn(0.85 MeV) vs the weight ratios of Ge/Fe were plotted and the linear relation was obtained. Germanium in iron oxide was determined nondestructively to about 0.1%. (auth)

12357 COPRECIPITATION OF URANIUM(VI) WITH IRON(III) HYDROXIDE PRECIPITATE. Ishibashi, Masayoshi; Fujinaga, Taitiro; Kumamoto, Tooru; Ogino, Yoshinori (Kyoto Univ.). Nippon Kagaku Zasshi, 88: 73-6(Jan. 1967). (In Japanese).

The coprecipitation of uranium(VI) with iron(III) hydroxide is described. A definite amount of freshly prepared precipitate iron(III) hydroxide was added to the solution containing uranium(VI) and the solution was kept standing for 16 hr. After the solution was filtered off through a membrane filter, the precipitate was dissolved in hydrochloric acid, and then the uranium was determined spectrophotometrically using arsenazo III to develop the color. Almost 100% of uranium(VI) was coprecipitated with iron(III) hydroxide in the pH range of 4.8 to 6.0, but the percentage of coprecipitation was rapidly decreased with increasing pH of the solution over 7.0. The presence of carbonate ions in the solution hindered the coprecipitation of uranium(VI) to a relatively great extent: the presence of carbonate equivalent to the content in a natural sea water at pH = 8.2 reduced the precipitation from 65 to 16%. It was concluded that uranium(VI) caused almost no deposit in sea water because of the formation of carbonate complex. (auth)

12358 EXTRACTION-PHOTOMETRIC DETERMINATION OF PLUTONIUM(IV) BY MEANS OF THENOYLTRIFLUOROACETONE. Palei, P. N.; Milyukova, M. S. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 22: 50-6 (Jan. 1967). (In Russian).

Plutonium(IV) thenoyltrifluoroacetonate (TTA) was quantitatively extracted with benzene from 0.1 to 1 M solution of nitric, hydrochloric, perchloric acids, but not successfully from sulfuric acid solutions. The absorption curve of the plutonium extract has a maximum at 410 nm. The molar extinction coefficient of the complex is $\epsilon_{410} = 8100 \pm 200$. The effects of thenoyltrifluoroacetone and plutonium concentration, time of phase contact, and nature of the organic solvent on the plutonium extraction and absorption of the Pu–TTA complex were studied. An extraction-photometric method for plutonium(IV) determination was suggested, which is based on plutonium extraction with a 0.1 M solution of TTA and on measuring the light absorption of the extract. Milligram amounts of Ag^{+}, Mn^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+}, Cr^{3+}, La^{3+}, Bi^{3+}, Th^{4+}, and UO_2^{2+} did not interfere with the determination of microgram amounts of plutonium(IV). Citric, acetic, and tartaric acids up to concentrations of 2.5×10^{-2} M did not interfere, whereas Fe^{3+}, Zr^{4+}, and oxalate ions interfered. (auth)

12359 A HIGHLY SELECTIVE METHOD FOR DETERMINING THORIUM BY MEANS OF METHYLDIANTIPYRYLMETHANE. Zhivopistsev, V. P.; Pyatosin, L. P. (Gor'kii Perm State Univ.). Zh. Anal. Khim., 22: 70-3(Jan. 1967). (In Russian).

A study was made of the extraction of thorium from nitric acid mediums using methyldiantipyrinylmethane. The ratio between thorium and the reagent in the extracted complex compound was found to be 1:2. Optimum conditions for extracting thorium were found, and the behavior of other elements in the nitrate system was studied. A method was developed for determining thorium in materials containing Zr, Hf, Sc, Y, rare earth elements, Ti, Sn, Pb, Bi, Fe, Mo, Ga, In, Hg, V, Ni, Co, and other elements. (auth)

12360 DETERMINATION OF DIFFERENT VALENCY URANIUM IN MIXTURES OF OXIDES CONTAINING IRON. Tserkovnitskaya, I. A.; Bykhovtseva, T. T. (Zhdanov Leningrad State Univ.). Zh. Anal. Khim., 22: 96-100(Jan. 1967). (In Russian).

A study was made of the polarographic behavior of Fe(II) in the system H_3PO_4–Complexon III. It was found that Fe(II) forms a compound with Complexon III in phosphoric acid (1:1.5). U(IV) and U(VI) were brought into solution without changing their valency. The extraction separation of U(IV) from solutions of complex composition and its amperometric determination in a nonaqueous medium by the Arsenazo III current were carried out. (auth)

12361 DETERMINATION OF MICROIMPURITIES IN NEODYMIUM, SAMARIUM, AND DYSPROSIUM OXIDES. Pavlenko, L. I.; Laktionova, N. V.; Sklyarenko, Yu. S. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 22: 104-10(Jan. 1967). (In Russian).

A number of carriers used in the analysis of rare earth elements for impurities by the method of fractional distillation were studied. It was found that the best carrier for the determination of impurities in neodymium, samarium, and dysprosium oxides is gallium oxide. The purification of neodymium, samarium, and dysprosium compounds from Cu, Mn, Cr, Ni, Co, Fe, Al, Si, Ca present as microimpurities by their precipitation as hydroxides or oxalates was investigated. The concentration of the impurity element was carried out to the content from 1×10^{-3} to $n \times 10^{-5}$% depending on the impurity. Spectrographic quantitative methods for determining Cu, Mn, Cr, Co, Ni, Fe, Al, Ca, and Si in neodymium, samarium, and dysprosium oxides were developed. The methods are based on fractional distillation with a carrier. The sensitivity of the methods is $n \times 10^{-5}$ to 1×10^{-3}% and reproducibility is ±5 to 15% depending on the basis, impurities determined, and their concentration. (auth)

12362 DETERMINATION OF IMPURITIES IN IRON BY NEUTRON ACTIVATION METHOD. Artyukhin, P. I.; Gil'bert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Academy of Sciences, Novosibirsk, USSR). Zh. Anal. Khim., 22: 111-13(Jan. 1967). (In Russian).

A method was investigated for the radioactivation determination of Co, Cu, In, Zn, As, Te, and Sn as microimpurities in iron of high purity. After radioactivation of the sample, iron was separated by extraction with β,β'-dichlorodiethyl ether from concentrated hydrochloric acid. Impurities which remained in the aqueous phase were separated on the Dowex 1 anion exchanger in the F^{-} form into two groups: Co, Cu, In, Zn; and As, Te, Sn. The elements of the first group were determined γ spectrometrically without any further separation. The elements of the second group were separated on the Dowex 1 resin in the Cl^{-} form. The quantitative determination of microimpurities was carried out by comparing the activity separated from the sample with that of the corresponding standard. (auth)

12363 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. COMMUNICATION 9. CINNAMATES OF THE RARE EARTH ELEMENTS AND YTTRIUM AS A WEIGHT FORM FOR THEIR DETERMINATION. Ostroumov, E. A.; Volkov, I. I. (Inst. of Oceanology, Moscow). Zh. Anal. Khim., 22: 30-3(Jan. 1967). (In Russian).

The rare earth elements and yttrium were quantitatively precipitated with ammonium cinnamate from weakly acid solutions on heating. Under certain conditions they formed cinnamates of constant composition which correspond to a general formula $R(C_6H_5CH:CHCOO)_3$ where R is a rare earth element or yttrium. These compounds can be weighed and their weight can be evaluated in the form of oxide or metal by means of calculated factors. (auth)

12364 SPECTROPHOTOMETRIC DETERMINATION OF TERBIUM. Ganopol'skii, V. I. (Inst. of Physics of Solids and Semi-

conductors, Minsk). Zh. Anal. Khim., 22: 40-4(Jan. 1967). (In Russian).

Conditions were studied for spectrophotometric determination of terbium (the absorption band with λ_{max} = 219 nm) in mixtures of rare earth elements containing middle lanthanides (from samarium to dysprosium) and yttrium. It was found by studying the spectrophotometric characteristics of yttrium in the spectrum range from 300 to 208 nm that yttrium has a broad diffuse absorption band with an indistinct maximum at 209 to 211 nm. The light absorption of yttrium salt solutions (chlorides and chlorates) obeys Beer's law to 20 mg/ml of Y_2O_3. Several methods for terbium determination in the concentrates of middle lanthanides and in yttrium oxide have been suggested. The yttrium absorption was taken into account or compensated during measuring the optical density of the analyzed solutions vs the standard yttrium solution. A method of two-side differential spectrophotometry is suggested which permits an increase in the range of determined concentrations and the accuracy of measuring. (auth)

12365 METHOD OF RADIOCHEMICAL SEPARATION OF ^{7}Be, ^{32}P, ^{33}P, AND ^{35}S FROM A SINGLE SAMPLE IN STUDIES OF ATMOSPHERIC PRECIPITATION AND AEROSOLS. Rysev, O. A.; Rosyanov, S. P.; Zhilkina, M. I.; Gedeonov, L. I. Radiokhimiya, 8: 251-4(1966). (In Russian).

A method for radiochemical separation of ^{7}Be, ^{32}P, ^{33}P, and ^{35}S is proposed which, in addition to an analysis of atmospheric precipitation, permits a study of samples of atmospheric aerosol collected on fibrous filters. The method involves the removal of fission products (present in the atmosphere following nuclear tests) from the nuclides ^{7}Be, ^{32}P, ^{33}P, and ^{35}S being determined. After the isotopes interfering with the determination of ^{7}Be have decayed, the γ radiation of ^{7}Be can be measured directly with β spectrometers, but the sulfur and phosphorus isotopes, in view of their small amounts and low energies of their β radiation (E_{max} = 0.26 MeV for ^{33}P and E_{max} = 0.16 MeV for ^{35}S), have to be separated radiochemically before they are determined. The radiochemical analysis involved use of isotopic dilution. Half lives of the four radioisotopes were measured. (JPRS)

12366 QUANTITATIVE DETERMINATION OF MERCURY IN HAIR BY ACTIVATION ANALYSIS. Hoshino, Otomatsu (Tokyo Univ.); Ouchi, Atsuhiro. Eisei Kagaku, 12: 94-9(Apr. 1966). (In Japanese).

Activation analysis has been applied to the quantitative determination of Hg in human hair. Results of activation analysis are compared with the results obtained by the conventional colorimetric dithizone method. Results are reported for determinations on hair sampled from people in Japan and other countries. The distribution of Hg along the length of the long hairs obtained from "Minamata diseased" patients and their families in the Niigata prefecture were determined by the nondestructive method and are reported. (TSS)

12367 PURITY CONTROL OF "SIX-NINE" LEAD BY NEUTRON ACTIVATION ANALYSIS. PART I. DETERMINATION OF GOLD, SILVER, ARSENIC, GERMANIUM, ANTIMONY, TIN, AND BISMUTH. Bianchini, A.; Lanfranco, G. (Centro Richerche Metallurgiche, Turin). Chim. Ind. (Milan), 48: 816-23(Aug. 1966). (In Italian).

A method is described in which inverted isotopic dilution is used for determining impurities in high-purity (99.9999%) Pb. After neutron irradiation the sample is attacked with nitric acid; during this treatment carrier solutions of the elements to be determined are added. Au, Ag, As, Ge, Sb, Sn, and Bi are separated in different chemical forms, and are thoroughly purified. The extent of recovery after the separation is established by chemical determination. Beta activity of radionuclides thus separated is measured with a front-window G-M counter; γ activity is measured with a NaI(Tl) scintillation detector and a pulse-height, single-channel analyzer. Quantitative determination is made by comparison with the activity of a known amount of the analyzed element, irradiated together with the sample being tested. The equipment required is inexpensive; the method is simple, sensitive, and fairly accurate. (BBB)

12368 METHODS FOR DETERMINING NATURAL URANIUM IN URINE. Zsoldos, T.; Csoevari, S.; Toth, A.; Nagy, L. (Hospital of Baranya County, Pecs, Hung.). pp 129-32 of II. Symp. Health Phys., Pecs, Hungary, Sept. 26-30, 1966. Budapest, Eoetvoes Lorand Physical Society, 1966.

Two rapid yet sensitive methods were developed to monitor the U levels in the urine of uranium miners. The first method involves determination of natural U by means of α counting. The urine is boiled with HNO_3 at a concentration of 4 to 5 N to free the U from the organic constituents. The acid also serves as a salting agent for the extraction of the U with TBP. After the U is extracted with 100 ml of a 10% solution of TBP in benzene, the organic phase is re-extracted with a 10% ammonium carbonate solution. The re-extract is dried and counted, water is added, and the distillation residue placed on a steel specimen tray of previously determined acid resistance background. This residue is distilled with a low-background α counter. With a starting volume of 1 liter, the recovery efficiency of this method is 95 ± 3%, and the lower limit of sensitivity is 6.2×10^{-1} μg U/l. The second procedure involves precipitation of the U with a Ca carrier by tannic acid, dissolution of the precipitate in concentrated HCl, reduction of the U(VI) to U(IV) by Zn filings, and photometric determination of the U as the U(IV)-arsenaso complex using an S-66 color filter. (BBB)

12369 DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS. 2. A SIMPLIFIED PROCEDURE FOR ISOTOPE-RATIO ANALYSIS OF SOIL NITROGEN. Cheng, H. H. (Washington State Univ., Pullman); Bremner, J. M. Soil Sci. Soc. Amer., Proc., 30: 450-3(July-Aug. 1966).

A simplified procedure for isotope-ratio analysis of soil nitrogen without ammonia distillation is described. The nitrogen in the soil sample is converted to ammonium by Kjeldahl digestion without use of a catalyst; digestion is accomplished by heating the sample with sulfuric acid containing a high concentration of potassium sulfate (ca. 0.7g/ml of H_2SO_4). An aliquot of the digest is partially neutralized and treated in vacuo with alkaline hypobromite-iodide solution, and the N_2 liberated by this treatment is analyzed for ^{15}N by the mass spectrometer. This modified procedure eliminates problems encountered in distillation and concentration of ammonium samples for ^{15}N analysis. Results obtained using different procedures for nitrogen isotope-ratio analysis of unamended soils and of soils treated with ^{15}N-enriched $(NH_4)_2SO_4$ before analysis are shown. The nitrogen isotope-ratio values obtained in these analyses by the procedure described were identical to those obtained by mass spectrometer analysis of the N_2 liberated by direct treatment of these solutions with alkaline hypobromite-iodide solution. Only trace amounts of oxygen were detected in the mass spectra of nitrogen gas samples obtained by the procedure described. The data provides confirmation of previous evidence that there is variation in the abundance of ^{15}N in soils. (BBB)

12370 PURITY CONTROL OF "SIX-NINE" LEAD BY NEUTRON ACTIVATION ANALYSIS. PART II. DETERMINATION OF COPPER, CADMIUM, COBALT, IRON, GALLIUM, INDIUM, NICKEL, AND ZINC. Bianchini, A.; Lanfranco, G. (Centro Richerche Metallurgiche, Turin). Chim. Ind. (Milan), 48: 823-9(Aug. 1966). (In Italian).

The method, which is described, is the same as that reported in Part I of this series for neutron activation analysis of Pb which is 99.9999% pure. Following neutron irradiation, the sample is treated with nitric acid and carrier solutions are added of the elements to be determined. Cu, Cd, Co, Fe, Ga, In, Ni, and Zn are separated in various chemical forms, and thoroughly purified. Methods involving chemical determinations are used for establishing the effectiveness of the separation of these elements. The β activity of radionuclides thus separated is measured with a G-M counter; γ activity is measured with a NaI(Tl) scintillation detector, and a pulse-height single-channel analyzer. Quantitative determination is made by comparison with the activity of a standard amount of the analyzed element irradiated together with the sample. Advantages of the method are discussed. (BBB)

12371 STUDY OF 14-MeV NEUTRON-INDUCED REACTIONS FOR ANALYSIS OF TRACE FLUORIDES. Nargolwalla, Sam. Toronto, Univ. of Toronto, 1965.

Thesis.

Three general methods, adequately tested with practical examples, are discussed for the study of 14-MeV neutron-induced reactions for trace analysis of fluorides. The design and construction of a complete fast-activation facility associated with a 14-MeV neutron source are described. The flow method allows a rapid and continuous activation analysis of fluorides in liquid streams. Fluoride concentrations as low as one ppM with a precision of 10% can be measured using a comparison activation technique. The procedure involves analysis of suitably discriminated gamma spectra generated from the induced $^{19}F(n,p)^{19}O$ reaction with two 2" × 2" NaI detector-single channel analyzer systems. A significant feature of the apparatus is the design and arrangement of an efficient twin-flow liquid irradiation assembly. Under optimum experimental conditions, it was established that the concentrations of interfering elements in drinking water yielding the same counting rate as one ppM of fluoride were: nitrogen, 200 ppM; silicon, 15 ppM; oxygen, ~10^6 ppM; sulfur, >10^3 ppM; sodium, 90 ppM; chlorine, >10^3 ppM; magnesium, 330 ppM; potassium, >10^3 ppM; and aluminum, 50 ppM. In addition, a method of measuring and correcting for the inherent interference from ^{12}N produced by recoil proton reactions with oxygen in aqueous media is also presented. This flow method is found to be successful with abnormally hard water samples.

The second method includes an ion-exchange concentration step prior to activation analysis. The fluoride-resin matrix is transported rapidly in a specially designed pneumatic transfer system to the counting area where, by suitable scintillation spectrometry using a 3″ × 3″ NaI detector-400 channel analyzer, the fluoride activity is determined. Sensitivities using $^{19}F(n,p)^{19}O$ and $^{19}F(n,2n)^{18}F$ reactions of 25000 ppM and 1600 ppM respectively are reported. Analysis time for a single determination varies from 2 to 6 hr. The third method, which consists of irradiating fluoride in a distilled water matrix, gives a sensitivity of 200 ppM fluoride. The procedure takes about 4 hr and includes a gross decay analysis with a 1¾″ × 2″ well-type NaI scintillation counter. The fluoride content of a tea sample analyzed by this method is reported. In addition to possible applications for fluoride analyses in other media, this investigation demonstrates the potential advantages of fast-neutron activation analysis of flow systems. (Dissertation Abstr.)

12372 METHOD OF OPERATING AN ION SOURCE FOR A TIME OF FLIGHT MASS SPECTROMETER. Studier, Martin H. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,434. Jan. 3, 1967.

A method of operating a time-of-flight mass spectrometer ion source having a backing plate and first and second grids is described. The method comprises generating positive ions between the backing plate and the first grid and periodically generating a negative potential pulse. Each of the negative potential pulses are applied to the first grid while the integral of each of the negative pulses is applied to the backing plate. A negative potential is continuously applied to the second grid. (AEC)

12373 PRINCIPLES OF RADIOISOTOPE METHODOLOGY. Chase, Grafton D.; Rabinowitz, Joseph L. Minneapolis, Burgess Publishing Co., 1965. 382p.

Progress in the basic science of radioisotopes is reviewed in this elementary lab manual for technicians, advanced medical students, and researchers who find the use of radioisotopes helpful in their work. Topics discussed include: radiation detection and measurement; radioactive decay; properties of radiation and interaction with matter; identification and calibration of nuclides; radiochemical separation techniques; and radioisotopes in biology and chemistry. Glossaries are included for nuclear terms and for symbols and abbreviations. Experiments with varying degrees of complexity are described. Among these are: properties of neutrons; the vibrating-reed electrometer; gamma spectrometry; activation analysis; radiation chemistry; and recoil reactions. (P.C.S.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 12467, 12505, 13232, and 13648.

12374 (ANL–7250) A THERMODYNAMIC STUDY OF THE WUESTITE PHASE. Ackermann, R. J.; Sandford, R. W. Jr. (Argonne National Lab., Ill.). Sept. 1966. Contract W-31-109-eng-38. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The thermodynamic properties of the FeO_{1+x} phase were measured over a temperature range of 970 to 1280°K by determining the values of x for known pressures of oxygen. Free energies, enthalpies, and entropies, as well as their respective trends with composition and temperature, were derived from the measured quantities, the Gibbs-Duhem equation, and calorimetric data. In addition to being more precise, the results correspond to a much lower temperature range than those reported in most of the earlier studies. The behavior of the partial molar quantities for oxygen and iron suggests the likelihood of the existence of a complicated temperature-dependent microstructure or superstructure and illustrates the need for an investigation to elucidate the structural changes that must occur as functions of temperature and composition. (auth)

12375 (BM-RI–6902) HEATS OF FORMATION OF YTTERBIUM AND THULIUM TRICHLORIDES. Stuve, J. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Sept. 1966. 14p. Bureau of Mines Free.

Standard heats of formation (ΔH_f^0) of $YbCl_3$ (c) and $TmCl_3$ (c) were measured by solution calorimetry. Heat-of-solution data are given for ytterbium and thulium metals and corresponding anhydrous trichlorides in 4.360 molal hydrochloric acid. The derived standard heats of formation of $YbCl_3$ (c) and $TmCl_3$ (c) were −229,370 ± 720 and −235,820 ± 400 cal/mole, respectively, at 298.15°K. The resulting heats of formation for $YbCl_3$ and $TmCl_3$ are about 1 and 6.3 kcal more negative than previously published values. (auth)

12376 (K-L–6136) SCATTERING OF HELIUM FROM THE CLEAVAGE PLANE OF LITHIUM FLUORIDE. Crews, J. C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 1966. Contract W-7405-eng-26. 13p. (CONF-661209–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Fundamentals of Gas-Surface Interactions, San Diego, Calif.

The intensity and direction of specular and diffracted beams were obtained in scattering planes containing the (−1,−1) and (0,−1) diffraction peaks. Deviations from a prediction were observed and an explanation offered based on assumptions about the structure of the surface. The interpretation of previous investigators that decreases in specular intensity with increasing incident angle are caused solely by surface roughness is questioned and it is suggested that at least part of the specular intensity decrease can be accounted for by a gain in diffracted intensity. Serious disagreement of experimentally determined diffraction intensities with the theoretical results of Lennard-Jones and Devonshire was found. Some of the assumptions in the theory are discussed. Well defined specular intensity minima were found for certain values of the azimuth angle similar to previous work of Frisch and Stern. Utilizing a theoretical analysis of Devonshire, some details about the energy of adsorption are inferred. (auth)

12377 (LA–3597) AN IMPROVED CALCULATION OF THE IDEAL GAS THERMODYNAMIC FUNCTIONS OF SELECTED DIATOMIC MOLECULES. Feber, R. C.; Herrick, C. C. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Ideal gas thermodynamic functions of selected diatomic molecules were calculated to 6000°K at 100°K intervals by direct summation over experimental and extrapolated vibrational-rotational levels of electronic states, which contribute to the functions at the maximum temperature. The procedure used for the extrapolation of energy levels allows for cutoff of both vibrational and rotational quantum numbers. Thermodynamic functions are tabulated for F_2, Cl_2, Br_2, I_2, HF, HCl, HBr, HI, Li_2, Na_2, K_2, B_2, C_2, and HgH. (auth)

12378 (LA–3618) EFFECT OF CONTAMINANTS ON THE HIGH TEMPERATURE PROPERTIES OF CARBIDE–GRAPHITE COMPOSITES. Davidson, K. V.; Riley, R. E.; Taub, J. M. (Los Alamos Scientific Lab., N. Mex.). Sept. 26, 1966. Contract W-7405-eng-36. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effects of process variables on the high-temperature properties of hot-pressed carbide–graphite composites are considered. The effects of contaminants in the starting powders were investigated by holding the process variables constant. The results of the effect of contaminants are reported and show a correlation between Fe content and high-temperature resistance to deformation. (auth)

12379 (LA-DC–8154) SURFACE CONFIGURATIONS OF THE (111) PLANE OF UO_2. Ellis, W. P. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 13p. (CONF-661209–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Fundamentals of Gas-Surface Interactions, San Diego, Calif.

The (111) surface of nearly stoichiometric uranium dioxide was investigated by low-energy electron diffraction. For a "clean" surface the sharp spots as low as 10V demonstrated that the bulk crystallinity continues to the outermost layer. Exposure to H_2, N_2, CO_2, CO, and H_2O at pressures up to 10^{-6} torr in the range from 22 to 700°C did not alter the pattern. Exposure to O_2 produced several structures dependent on oxide source, temperature, oxygen pressure, composition of UO_{2+x}, and surface roughness. Although the conditions of formation varied, three characteristic stages were observed in the interaction of UO_2(111) with O_2 at 10^{-6} torr: at 22°C, a well-defined ring around each diffraction spot; for intermediate temperatures, two structures (at 200°C or below a P(3 × 3) pattern and between 320 and 390°C, a 1/12 monolayer pattern); above 450°C no fractional spots. (auth)

12380 (MLM–1342) MOUND LABORATORY QUARTERLY PROGRESS REPORT, APRIL–JUNE 1966. Eichelberger, J. F.; Grove, G. R.; Gnagey, L. B. (Mound Lab., Miamisburg, Ohio). Jan. 27, 1967. Contract AT(33-1)-Gen-53. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: half-life determination by decaying pairs; separation and half-life determination of radon-219; half-life of ^{215}Po; levels in ^{219}Rn populated by alpha decay of ^{223}Ra; valence instability of ^{238}Pu; actinide complexes; hydrolysis of uranyl nitrate; structure of uranyl nitrate hydrates; thermal dehydration of uranyl nitrate hexahydrate; ^{229}Th recovery; NMR and tritium bremsstrahlung counting methods for analyzing

elements and compounds; and preparation of filled plastics, foams, and adhesives for specialized applications. (P.C.H.)

12381 (NP-16454) ACTION DU TRIFLUORURE DE CHLORE SUR LA VAPEUR D'EAU. ANALYSES DES PRODUITS DE REACTION. Rapport Technique 589. (Effects of Chlorine Trifluoride on the Water Vapor. Analysis of Reaction Products. Technical Report 589). Bougon, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1961. 70p. (In French). Dep. mn.

The reaction of ClF_3 with H_2O was studied. The devices used for the study were a separator operating on water vapor, an infrared spectrometer, and a spectrophotometer for the visible and near uv. The methods used for the determination of ClF_3 are described. Preliminary studies on the reaction in the vapor phase and in excess ClF_3 showed that ClF_3 in excess reacts with H_2O in the proportion 1/1. All the hydrogen of the H_2O goes to HF. Among the reaction products are ClO_2F and ClO_3F, HF, and possibly ClO_2, Cl_2, and O_2-ClF. The reaction velocity is apparently limited by the desorption phenomenon. Characteristics of the principle products possibly formed during the reaction are outlined. The reaction products can be analyzed by infrared spectrography. (J.S.R.)

12382 (ORNL-3970, pp 45-7) SPECTROSCOPY OF IONIC MEDIA. Smith, G. P. (Oak Ridge National Lab., Tenn.).

Topics investigated by means of optical spectroscopy included vibrational-electronic transitions in ionic crystals, coordination geometry, and unusual electronic structures in ionic melts. (auth)

12383 (RT-PROT-(66)18) A STUDY ON THE SORPTION PROPERTIES OF THE NATURAL TUFFS OCCURRING IN THE LAKE BRACCIANO REGION (ROME). Report No. 3. Boenzi, D.; Dlouhy, Z.; Lenzi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 16p. Dep. mn.

Some physicochemical properties were studied on four samples of tuff selected among those having a high distribution coefficient for Cs and Sr. Density, ion exchange, and recovery possibility of the sorbed nuclides were investigated. The recovery possibility was studied by experiments in static conditions (batch) and dynamic conditions (columns). Data about the standard free energy variation are presented for ion exchange reactions and separation factors for the different samples in regard to certain cations. (auth)

12384 (TID-23528) INVESTIGATION OF COALESCENCE OF SOLID-LIQUID SYSTEMS. Report No. 0780-02(01)-FP. Period Covered: February 1, 1965-January 30, 1967. (Aerojet-General Corp., Downey, Calif.). Jan. 1967. Contract AT(04-3)-474. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An investigation of controlling parameters for coalescence in solid-liquid (water) systems was conducted. A literature search was made for background information on surface energy determinations and coalescence mechanisms. Critical surface energy values were measured for solid surfaces such as glass, coatings on glass, graphite, and nylon using the contact angle technique. Coalescence-time measurements were made by high-speed photography. An inverse relation was shown between the coalescence delay time and critical surface energy of the solid. Measurements of delay times with varying electrical potential between the solid and water droplet were made. Conducting solids and nonconducting solids with conducting coatings showed voltage effects on coalescence time. No significant effects were observed for nonconducting surfaces. Spreading rates were determined from high-speed photographic measurements. The rate of increase in diameter of the wetted area (wetting rate) fell in the range of 0.76 to 1.43 m/sec at an arbitrary time after initiation of wetting. The rate values exhibited no clear relation to the critical surface energies or delay time measurements. (auth)

12385 (UCRL-14288) JAPANESE RESEARCH IN PHYSICS AND CHEMISTRY INDEX AND TRANSLATED CONTENTS OF BRUSSEIRON-KENKYU (1943-1962). Brush, Stephen; Bloom, Penelope; Kingsbury, Raphaella; Ozawa, Shuji (California Univ., Livermore. Lawrence Radiation Lab.). June 30, 1965. Contract W-7405-eng-48. 170p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The journal Busseiron-Kenkyu published research papers in physics and chemistry during the period 1943 to 1962. The tables of contents of each of the 169 issues published, translated into English, and a comprehensive subject index to all the articles are presented. All the articles were checked in Chemical Abstracts and the abstract number is indicated in those cases where there was an abstract of the Busseiron-Kenkyu article, or of an article with a similar title in another journal. The subjects covered by these articles are indicated in the following list of those categories to which 40 or more titles were assigned in the index: magnetic properties (including antiferromagnetism, ferromagnetism, and paramagnetism), polymers, electric and dielectric properties, transport theory, quantum chemistry, statistical mechanics, electrons, liquid helium and Bose-Einstein systems, metals and solid state, phase transitions, semiconductors, cooperative phenomena including order-disorder transitions and the Ising model, alkali halide and ionic crystals, and quantum mechanics. (auth)

12386 (UJV-1332/65) EFFECTS OF PREPARATION METHODS ON THE SURFACE AREA AND STRUCTURE OF AMMONIUM POLYURANATE. Jakes, D.; Landspersky, H.; Sedlakova, L.; Sulc, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1965. 31p. DTIE.

Relations between conditions of preparation of ammonium polyuranate as used on a technologic scale, variations of specific surface area and structure, and the composition of the precipitate were studied. Two maxima of specific surface area of the precipitate were found at pH = 5 and pH = 7 to 8. All four types of structures found by Cordfunke were observed and their dependence on pH was determined by precipitating at a given ionic strength of the solution. Possibilities of correlating the composition, structure, and specific surface area of ammonium polyuranate are discussed. (auth)

12387 (UJV-1521) HYDROTERMALNI SYNTEZY V SYSTEMU UO_3-H_2O. Studie Infracervenych Spekter. (Hydrothermal Synthesis in UO_3-H_2O Systems. Studies of Infrared Spectra). Urbanec, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 38p. (In Czech). DTIE.

Several hydrates of UO_3 (α-$UO_3 \cdot H_2O$, β-$UO_3 \cdot H_2O$, and $UO_3 \cdot 0.5H_2O$) and the corresponding deuterates were prepared by means of heating uranium oxides, and in one case an acetate, with H_2O or D_2O to temperatures of 150 to 330°C. The infrared spectra were determined for the pure products and are tabulated; interpretations are also given. The β-UO_3 deuterate was much more difficult to make than the hydrate under the same conditions and required both a longer time and a higher nitrate ion concentration. Above 180°C in silica-containing reaction vessels a uranyl silicate was formed. Also tabulated are literature data (24 references) on preparation and crystal structure characteristics of α-$UO_3 \cdot H_2O$, β-$UO_3 \cdot H_2O$, and $UO_3 \cdot 0.5H_2O$. (TTT)

12388 (Y-1564) PURIFICATION OF URANIUM BY ZONE-REFINING TECHNIQUES. Bieber, J. L.; Schreyer, J. M.; Williams, E. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 7, 1967. Contract W-7405-eng-26. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A zone-refining technique was established for purifying uranium in gram quantities to less than 30 ppM total impurities. (auth)

12389 MIRROR SYMMETRY AND NATURE OF ELECTRONIC ABSORPTION SPECTRA OF URANYL COMPOUNDS. II. Seuchanka, A. N.; Umreika, D. S. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 45-51(1963). (In Ukrainian).

An experimental study was made of the duration and quantum yield of fluorescent series of uranyl compounds. A comparison of the results obtained with the inverse of the integral absorption in the visible range of the spectra of these compounds confirmed the presence of some excited electron states of the uranyl ions. Analogous conclusions were drawn from polarization measurements. (tr-auth)

12390 STUDIES ON URANYL COMPLEXES. I. URANYL COMPLEXES OF E.G.T.A. Frausto da Silva, J. J. R.; Simoes, M. Lourdes Sadler (Instituto Superior Tecnico, Lisbon). Rev. Port. Quim. (Lisbon), 7: 137-44(1965).

The uranyl complexes of EGTA—[ethylenebis(oxyethylenenitrilo)] tetraacetic acid—were studied by potentiometric and absorptiometric methods. Evidence is presented for the formation in solution of the species $UO_2(H_2O)HY^-$, $(UO_2)_2(H_2O)_2Y$, $(UO_2)(HO)HY^{2-}$, $(UO_2)_2(HO)(H_2O)Y^-$, and $(UO_2)_2(HO)_2Y^{2-}$; their respective formation constants were determined by potentiometric measurements. The species $Na(UO_2)(H_2O)HY$ and $(UO_2)_2(H_2O)_2Y$ were isolated in solid form; ir spectra gave evidence for considerable covalent character in uranium—oxygen bonds and supported the formulation of the complexes with coordinated water and free carboxylate groups. (auth)

12391 INTERACTIONS BETWEEN MOLECULES AND SUPERCONDUCTORS. Hoffman, B. M.; Gamble, F. R.; McConnell, H. M. (Stauffer Lab. for Physical Chemistry, Stanford, Calif.). J. Amer. Chem. Soc., 89: 27-30(Jan. 4, 1967).

The superconducting transition temperature and critical current of thin vanadium films were increased when electron donors were deposited on the film surface and decreased when electron acceptors were deposited, the absolute magnitude of the change being ~0.1°K in both cases. Preliminary work with indium films indicates that acceptors decreased the transition temperature and critical current, but that donors did not increase them. (auth)

12392 FORMATION AND STABILITY OF URANYL HYDROQUINONATE. Rao, R. Raghava; Bhattacharya, P. K. (Vikram Univ., Ujjain, India). Curr. Sci. (India), 36: 71(Feb. 5, 1967).

Formation and stability of uranyl hydroquinonate was investigated. Stoichiometry of the complex was determined by titrating equimolar solutions of uranyl acetate and hydroquinone with alkali. Potentiometric and conductometric titrations of uranyl acetate with NaOH were carried out in the presence of hydroquinone. Results compared favorably with theoretical values. Stability constant was 21.17×10^{11}. ΔF was –16.84 K cal/mole. (P.C.S.)

12393 MECHANISM OF RADIOISOTOPE REDISTRIBUTION IN CO_2 DISSOCIATION IN A NOISELESS DISCHARGE. Semiokhin, I. A.; Andreev, Yu. P. (Moscow State Univ.). Zh. Fiz. Khim., 41: 64-70(Jan. 1967). (In Russian).

The isotopic redistribution mechanism in carbon dioxide dissociation was analyzed. The kinetic isotopic effects were computed by means of various approximations of the theory of active complex and equations of statistical mechanics. The theoretical and experimental data were in good agreement. Studies of the isotopic exchange between carbon dioxide and oxygen in a noiseless discharge in a gas stream showed that a complete isotopic exchange was fulfilled within 2 to 3 min or much more rapidly than under thermal conditions. (R.V.J.)

12394 KINETIC HYDROGEN ISOTOPE EFFECTS IN THE BROMINATION OF SOME POLYALKYLBENZENE SYSTEMS. Baciocchi, Enrico; Illuminati, Gabriello; Sleiter, Giancarlo; Stegel, Franco (Rome Univ.). J. Amer. Chem. Soc., 89: 125-9(Jan. 4, 1967).

The preparative, product analysis, and kinetic aspects for the determination of the kinetic hydrogen isotope effects, k_H/k_D, for the bromination of a number of polyalkylbenzene systems are described. The reaction was either bromination by molecular bromine in acetic acid and in nitromethane or silver ion catalyzed bromination in acetic acid–dioxane mixture (1,3,5-tri-t-butylbenzene). The isotope effect was found to be appreciably larger in nitromethane than in acetic acid solution (5-t-butylhemimellitene). Further evidence is presented in support of the view that steric hindrance at the reaction site is an important contributing factor for the occurrence of isotope effects in electrophilic aromatic substitution. (auth)

12395 FLUORINE OXIDATION OF TETRAVALENT URANIUM AND NEPTUNIUM TO THE PENTAVALENT STATE. Asprey, L. B.; Penneman, R. A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Amer. Chem. Soc., 89: 172(Jan. 4, 1967). (LA-DC-8258).

Fluorine oxidation of uranium tetrafluoride in liquid anhydrous HF produced UF_5 readily, UF_6 very slowly. When both alkali fluoride and UF_4 were present in liquid HF, fluorine oxidation halted at U(V) in the form of the soluble UF_6^- ion. An attempt to extend the technique to neptunium was made. Although oxidation of Np(IV) to Np(V) was observed in cesium hydrogen fluoride solution, NpF_5 was not isolated. (J.G.B.)

12396 THE CALCINATION OF TWO BeO POWDERS. Hey, A. W.; Livey, D. T. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc., 65: 627-42(Nov. 1966). (AERE-R-5066).

Two BeO powders prepared by the decomposition of hydroxides with different impurity contents were calcined in dry air for various times at different temperatures. The kinetics of crystallite growth, the variation of surface area, and the variation of powder characteristics as observed by electron microscopy, were studied as a function of temperature. The kinetics of crystalline growth over the temperature range from 600 to 900°C were found to obey the relationship $D^n - D_0^n = Kt$ with n equal 7 for one powder and 10 for the other; the apparent activation energies were ~61 and ~46 kcal/mol, respectively. From kinetic data and evidence obtained from surface-area measurements and electron microscopy, the crystallite growth process is discussed in terms of mechanisms possible at these and higher temperatures. (auth)

12397 CHELATION OF URANYL IONS BY ADENINE NUCLEOTIDES. Feldman, Isaac; Jones, Joann; Cross, Richard (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc., 89: 49-53 (Jan. 4, 1967).

Potentiometric titrations of equimolar mixtures of uranyl nitrate and the 5′-adenine nucleotides, the diprotonated species of adenosine triphosphate(H_2ATP^{2-}) protonated adenosine diphosphate($HADP^-$), and adenosine monophosphate(AMP) were performed. From the initial pH values and r values (i.e., moles of added base : moles of total nucleotide) at the first inflections, it was concluded that the number of protons which dissociate upon formation of the uranyl–adenosine triphosphate(U–ATP) and U–AMP complexes are one and two, respectively, and that an average of about 1.3 protons dissociated upon formation of the uranyl–adenosine diphosphate(U–ADP) complex. From a comparison of the U–ATP titration curve with that of Na_2H_2ATP, it appears that the first proton which dissociates upon formation of the U–ATP complex comes from a protonated adenine group; i.e., the terminal phosphate proton does not start to dissociate until sometime after the first inflection (pH 4.5). Both the dissolution and dephosphorylation of the precipitated complex began just after the first inflection. There was complete dissolution at about r = 2, at which point there was also the maximum rate of dephosphorylation. Titrations of U–adenosine, U–glycerophosphate, and U–(adenosine + glycerophosphate) mixtures and their comparison with the U–AMP curve showed that even though the uranyl ion does not react with adenosine it does attach to both the adenine and phosphate groups of AMP to form an intramolecular U–AMP chelate. All these facts are consistent with a U–adenine nucleotide chelate structure in which uranium is attached to an O atom of the α-phosphate group, the ribose ring oxygen, and the N_3 atom of the adenine ring, these ligands plus one water oxygen lying close to the equatorial plane of the uranyl group. (auth)

12398 EFFECT OF URANYL PERCHLORATE ON THE KINETICS OF POLYMERIZATION OF ACRYLAMIDE. Cavell, E. A. S.; Meeks, A. C. (Univ. of Southhampton, Eng.). Polymer, 8: 79-85(Feb. 1967).

The effect of uranyl perchlorate on the mechanism and kinetics of radical polymerization of acrylamide was investigated in aqueous solution over a range of temperatures, employing 4,4′-dicyano-4,4′-azopentanoic acid as initiator. All measurements were made in the complete absence of light. With no azo-initiator present, uranyl perchlorate was found to initiate polymerization of acrylamide, the rate of polymerization (R_p^0) observed being approximately proportional to the concentration of the uranyl salt. The overall rate of polymerization (R_p) with the azo-initiator present was directly proportional both to the concentration of monomer and to the concentration of the azo-initiator. Linear termination of polymerization was indicated by the fact that $(R_p - R_p^0)$ is approximately inversely proportional to the concentration of uranyl perchlorate. An electron transfer mechanism was proposed for the termination reaction and a dimeric ion, produced by the partial hydrolysis of the uranyl salt was suggested as the entity responsible for initiation. (auth)

12399 LIGHT AND HEAVY ACIDS DISSOLVED IN LIGHT OR HEAVY WATER. Halpern, Otto (American Express Co., Vienna). Acta Phys. Austr., 24: 185-6(1966).

Dilute solutions of a heavy acid in light water show the same conductivity as those of light acids of equal molality. A corresponding rule holds true if heavy water is the solvent. The new molecules HDO appearing in the solution give rise to additional thermodynamical effects. (auth)

12400 RELATIVE CONTRIBUTIONS OF HYPERCONJUGATION AND NONBONDED INTERACTIONS TO SECONDARY ISOTOPE EFFECTS. Karabatsos, Gerasimos J.; Sonnichsen, George C.; Papaioannou, Chistos G.; Scheppele, Stuart E.; Shone, Robert L. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc., 89: 463-5(Jan. 18, 1967).

Solvolytic rate constants and isotope effects for naphthalene derivatives are summarized. Relative contributions of hyperconjugation and nonbonded interactions to secondary isotope effects were investigated. In ordinary systems with hyperconjugation possible, less than 10% (probably 2 to 5%) of the observed isotope effect is due to nonbonded interactions; reasonable estimates of the nonbonded isotope effect might be obtained by using Bartell's procedure with the Scott and Scheraga functions. (P.C.S.)

12401 REACTIONS INVOLVING AN ISOTOPIC EXCHANGE OF HYDROGEN IN BENZENE DERIVATIVES CONTAINING CONDENSED POLYMETHYLENE CYCLES. Ginzburg, A. G.; Setkina, V. N. Dokl. Akad. Nauk SSSR, 169: 1080-2(1966). (In Russian).

Studies showed that hydrogen in the benzene rings of 5, 6, 7, 8-tetramethyltetrahydronaphthalene, 9, 10-dimethyl-sym-octahydrophenanthrene, and 7, 8-dimethylhexahydro-asym-indacene are capable of isotopic exchange with D_2SO_4 in nitrobenzene at room temperature. Proton resonance studies indicated that only hydrogen atoms in the β position in polymethylene links participitate in the exchange. The data obtained confirmed that the hydrogen isotopic exchange in acid media is characteristic of the hydrogen atoms of the β position of penta- and hexapolymethylene links condensed with benzene rings. (R.V.J.)

12402 ANODIC DISINTEGRATION OF METALS UNDERGOING ELECTROLYSIS IN AQUEOUS SALT SOLUTIONS. James, William J.; Straumanis, M. E.; Johnson, J. W. (Univ. of Missouri, Rolla). Corrosion, 23: 15-23(Jan. 1967).

Mechanisms of the anodic dissolution of metals in aqueous salt solutions are reviewed and discussed. The review places particular emphasis on metals studied in the authors' laboratories. (auth)

12403 RANGES OF COMPOSITION OF THE Th_2N_2O AND ThO_2 PHASES EQUILIBRATED WITH DIFFERENT NITROGEN (PLUS OXYGEN) ATMOSPHERES. Benz, R. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Amer. Chem. Soc., 89: 197-9(Jan. 18, 1967). (LA-DC-8145).

The Th_3N_4, Th_2N_2O, and ThO_2 phases were equilibrated with N_2 at different pressures and selected temperatures between 1600 and 2000°C. An appreciable homogeneity range in the Th_2N_2O and ThO_2 phases was revealed by microscopic examination of the cooled products. The compositions of all the phases and phase mixtures were found to be describable by the single formula $ThN_{z-(2z/3)}O_z$, where z is the composition variable ranging in value from 0 to 2. Accordingly, the elements in these phases exhibit valences identical with those of the ions Th^{4+}, N^{3-}, and O^{2-}. (auth)

12404 THE CRYSTAL STRUCTURE OF THE CHLOROFORM SOLVATE OF DIOXODI-8-QUINOLINOLATO-8-QUINOLINOLURANIUM(VI). Hall, D.; Rae, A. D.; Waters, T. N. (Univ. of Auckland, New Zealand). Acta Crystallogr., 22: 258-68(1967).

The crystal structure of the compound formed when uranium(VI) was precipitated with 8-quinolinol was determined by three-dimensional x-ray methods, and the molecule formed shown to be dioxodi-8-quinolinolato-8-quinolinoluranium(VI). Two 8-quinolinol molecules were coordinated as bidentate ligands and a third as a monodentate ligand, all three lying approximately in the plane normal to a near-linear uranyl group. Chloroform molecules which co-crystallize existed as solvent of crystallization only, and were slightly disordered. (auth)

12405 CRYSTAL STRUCTURE OF URANIUM PENTACHLORIDE. Smith, Gordon S.; Johnson, Quintin; Elson, Robert E. (Univ. of California, Livermore). Contract W-7405-eng-48. Acta Crystallogr., 22: 300-3(1967). (UCRL-14941).

UCl_5 forms monoclinic crystals with lattice constants: a = 7.99, b = 10.69, c = 8.48 Å; β = 91.5°. The space group is $P2_1/n$, and the unit cell contains four UCl_5 units. Full-matrix least-squares refinement of diffractometrically measured x-ray diffraction data resulted in a final R of 6.0%. The structure is based on a cubic closest packing of chlorine atoms, in which uranium atoms occupy one-fifth of the octahedral holes. Two such octahedra share an edge to form a dimeric U_2Cl_{10} unit. U-Cl distances involving bridging Cl are 2.67 and 2.70 Å; those involving non-bridging chlorine atoms are 2.43, 2.43, 2.44, and 2.44 Å. Uranium atoms in the U_2Cl_{10} units are each shifted by about 0.20 Å from the centers of the octahedra in directions away from one another. The relation of the structure of UCl_5 to those of $NbCl_5$ and α-UF_5 is discussed. (auth)

12406 PROTON MAGNETIC RESONANCE STUDIES AND EXTRACTION PROPERTIES OF SOME SIMPLE DIAMIDES. Siddall III, T. H.; Good, Mary L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem., 29: 149-58(Jan. 1967). (DP-MS-66-20).

The extraction capabilities of oxalamides, malonamides, and succinamides for nitric acid and the uranyl ion are discussed. The trends noted for the different classes of diamides are rationalized in terms of their proton magnetic resonance spectra. (auth)

12407 ADSORPTION OF THREE HYDROGEN ISOTOPES ON CHARCOAL. Jones, P. M. S.; Hutcheson, C. G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nature, 213: 490-1(Feb. 4, 1967).

Previous studies with hydrogen and deuterium were extended to tritium. Apparatus and experimental details are outlined. Plots of equilibrium pressures, P_e, against volumes of adsorbed gas, V_a, at liquid nitrogen temperature were good straight lines for all three isotopes at pressures >100mm, indicating that the adsorption follows the Langmuir isotherm. The volumes of gas adsorbed per gram of charcoal for monolayer coverage decreased in the sequence $T_2 > D_2 > H_2$ (approximately 136, 119, and 106 std ml/g). The isotope effect appeared to arise principally because of changes in monolayer volume, V_m, rather than because of adsorption-desorption energetics, an unexpected result since V_m should be a function of molecular size, which is almost identical for the three isotopic molecules, whereas molecular attraction forces and isotopic masses should affect the adsorption-desorption energetics. The isotope effect on V_m and the energetics may be explained if more energetic, and therefore less favorable, adsorption sites are available to the heavier molecules because of their higher heats of adsorption. A high pressure experiment using hydrogen at 1.5°C also conformed to the Langmuir isotherm, with V_m = 35 standard ml/g. The heat of adsorption for hydrogen on charcoal was calculated as 1.3 kcal/mole, in excellent agreement with results of other workers. (UK)

12408 SOME PHASE EQUILIBRIA IN THE THORIUM-NITROGEN SYSTEM. Benz, R.; Hoffman, C. G.; Rupert, G. N. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Amer. Chem. So., 89: 191-7(Jan. 18, 1967). (LA-DC-8146).

Portions of the Th-N phase diagram were determined by x-ray, microscopic, chemical, and thermal analyses of phases equilibrated with N_2 (up to 3 atm) at temperatures up to 2820°C. The Th-ThN portion of the phase diagram is a peritectoid-peritectic system wherein, upon heating, the face-centered-cubic (fcc) Th phase with a N:Th ratio 0.08 ± 0.02 decomposes peritectoidally at 1605 ± 20°C to body-centered-cubic (bcc) Th and ThN. The bcc Th phase with a N:Th ratio 0.09 ± 0.02 decomposes peritectically at 1800 ± 25°C to liquid Th and ThN. The Th-rich boundary of the ThN phase extends from the N:Th ratio 0.97 ± 0.03 at 1576 to 0.87 at 2000°C, while the N-rich boundary extends from the N:Th ratio 1.03 ± 0.03 at 1615 to 1.08 at 2065°C. The mononitride phase melts congruently at 2820 ± 30°C with the N:Th ratio 0.995 ± 0.005. The Th-rich boundary of the rhombohedral Th_3N_4 phase changes with increasing temperature from the N:Th ratio 1.33 at 1600 to 1.29 ± 0.03 at 1960°C. (auth)

12409 RELAXATION SPECTRA OF SOME URANYL AND VANADYL COMPLEXES IN AQUEOUS SOLUTIONS. Hurwitz, P.; Kustin, K. (Brandeis Univ., Waltham, Mass.). J. Phys. Chem., 71: 324-9(Jan. 1967).

The temperature-jump method was used to determine the kinetics of the reaction of UO_2^{2+} ion with monochloroacetate, sulfate, acetate, and thiocyanate, and of the VO^{2+} ion with thiocyanate. The UO_2^{2+} ion formed higher order complexes with the first three of these ligands, whereas for uranyl and vanadyl only the thiocyanate monocomplex was important. Bimolecular rate constants at 20°C and the given ionic strength for formation of the 1-1 uranyl complex were: SO_4^{2-}, 180 $\underline{M}^{-1}$ sec^{-1} at μ = 0.15 $\underline{M}$; $ClCH_2COO^-$, 110 $\underline{M}^{-1}$ sec^{-1} at μ = 0.15 $\underline{M}$; SCN^-, 290 $\underline{M}^{-1}$ sec^{-1} at μ = 1.2 $\underline{M}$; CH_3COO^-, 1050 $\underline{M}^{-1}$ sec^{-1} at μ = 0.15 $\underline{M}$. For the reaction between vanadyl and thiocyanate the rate constant was 160 $\underline{M}^{-1}$ sec^{-1} at 20°C and μ = 0.2 $\underline{M}$. Substitution labilized the water molecules still bound to the oxo ion, so that further substitution was accelerated. The effect, however, was not as pronounced as for divalent transition-metal ions. Complexation rates for uranyl ion were most nearly typical of 3+ ions. No clear-cut correlation between the formation rate constant and ligand basicity could be demonstrated for either cation. The principal effect the oxo ion had on the rate of complexation was exerted by the rather high positive charge density on the metal, especially for uranyl. The site of nucleophilic attack on vanadyl may play a role in the kinetics of substitution. (auth)

12410 ENERGY TRANSFER IN SOLUTION BETWEEN UO_2^{2+} AND Eu^{3+}. Kropp, John L. (TRW Systems, Redondo Beach, Calif.). Contract AF 33(615)-1968. J. Chem. Phys., 46: 843-7(Feb. 1, 1967).

Energy transfer from UO_2^{2+} to Eu^{3+} was observed in several solutions. Quantitative data for the quenching of UO_2^{2+} fluorescence at various Eu^{3+} concentrations and the corresponding build-up of Eu^{3+} fluorescence were obtained in D_2O solutions. Rate constants for the transfer of energy from UO_2^{2+} to Eu^{3+} are derived; the value is determined to be about 10^7 $\underline{M}^{-1}$ sec^{-1}. This value is less than the diffusion-controlled reaction rate. The low value can be related to mutual ion-ion repulsion. (auth)

12411 VARIATIONS IN THE CONTACT POTENTIAL DIFFERENCE OF RARE EARTHS OXIDES AS A FUNCTION OF THE TEMPERATURE OF ANNEALING IN OXYGEN. Sazonov, L. A.; Lyando, V. A. (Inst. of Catalysis, Academy of Sciences, Siberian SSR). Kinet. Kataliz, 7: 1094-5(Nov.-Dec. 1966). (In Russian).

Effects of thermal treatment (500 to 1000°C) on the magnitude of contact potential difference of Nd, La, Dy, Gd, Sm, and Ce oxides were determined. The lowest contact potential difference was observed in oxides annealed at 700°C. (R.V.J.)

12412 RELATIONSHIP BETWEEN THE SEPARATION FACTOR DURING ISOTOPIC EXCHANGE AND THE PROPERTIES OF THE EXCHANGING MOLECULES. Rozen, A. M.; Mikhailichenko, A. I. J. Nucl. Energy: Pt. A and B, 20: 785-98(Sept. 1966).

An examination is made of the dependence of the equilibrium constant during isotopic exchange in diatomic compounds on the properties of the exchanging atoms and molecules: the force constant, dissociation energy, electronegativity, structure of the electron shell, internuclear distance, masses of the isotopic and additional atom. Analytical equations describing the influence of these factors on the magnitude of the equilibrium constant are obtained with the aid of semi-empirical relations. Convenient methods of correlation are found which make it possible to predict the character of the variation in the β-factors in a number of similar compounds. Recommendations are given on the selection of systems for isotope separation. An attempt is made to extend some of the conclusions obtained to isotopic exchange in polyatomic compounds. (auth)

12413 REACTIONS OF SOLID SOLUTIONS OF U_3O_8–R_2O_3 (R IS La, Sm, Dy, AND Yb) WITH OXYGEN UNDER PRESSURE. Koshcheev, G. G.; Kovba, L. M. Vestn. Moskov. Univ., Ser. II: Khim., No. 3, 94-7(May-June 1966). (In Russian).

Coulometric and gravimetric analyses were made of the oxidation of solid solutions of $U_3O_8-R_2O_3$ (R is La, Sm, Dy, and Yb) containing 50 mole % of uranium oxides and placed in an oxygen-filled autoclave for 100 hr under 200 atm pressure at 650°C. X-ray analysis of oxidation products showed that mixed oxides of uranium and samarium oxidized to $\beta-UO_3$ with negligible variations in the interplane distances. With dysprosium oxides, uranium oxidized to $UO_{2.9}$, and with ytterbium oxides $\alpha-UO_3$ was formed. The $La_2O_3 \cdot 6UO_3$ compound at $R_2O_3 : UO_{2+x} = 1:6$ to 1:20 ratios was formed due to the higher degree of oxidation than in association with Sa, Dy, or Yb oxides, which did not form such compounds. (R.V.J.)

12414 STABILITY OF SOME COMPLEXES OF THE SALICYLALDEHYDE FORMYLHYDRAZONE. Sucha, L.; Suchanek, M. (Inst. of Chemical Tech., Prague). Collect. Czech. Chem. Commun., 31: 4539-62(Dec. 1966).

The composition of the complexes Cu^{II}, Ni^{II}, Zn^{II}, Co^{II}, and UO_2^{II} with salicylaldehyde formylhydrazone was studied by spectrophotometric methods and their conditional stability constants were determined. The dissociation constants of the salicylaldehyde formylhydrazone were determined in aqueous ethanol solution (40% by weight of ethanol, $\mu = 0.05$). The stability constants of variously protonized zinc(II), nickel(II), and copper(II) complexes, coexisting in the mixture, were calculated from the dependence of the conditional stability of the complexes on pH. The stability sequence of the complexes of the transition metals is in agreement with the Irving–Williams series as well as with the previously observed sequence of the interfering effect of these complexes on the fluorescence reaction of beryllium, aluminium, and other metals with the reagent mentioned. (auth)

12415 INFRARED SPECTRA AND MOLECULAR VIBRATIONS OF ETHYLENE GLYCOL AND DEUTERATED DERIVATIVES. Matsuura, Hiroatsu; Miyazawa, Tatsuo (Osaka Univ.). Bull. Chem. Soc. Jap., 40: 85-94(Jan. 1967).

The infrared spectra of ethylene glycol and ethylene glycol-d_2 were measured in the liquid and crystalline states in the region of 4000 to 300 cm^{-1}. The infrared and Raman spectra suggest that ethylene glycol molecule takes only the gauche conformation as to the C–C bond in both states (the likely models are TGT, TGG, and GGG). To establish the vibrational assignments, the normal coordinate treatments of ethylene glycol and its three deuterated derivatives were carried out for these models by the use of GF matrix method. The modified Urey-Bradley force field was used and the force constants were transferred from similar molecules. The potential energy distributions were calculated and the nature of the observed infrared bands and Raman lines in the liquid state are discussed. The previous empirical assignments of the methylene rocking modes were revised by the present normal coordinate analyses. (auth)

12416 FLAME PHOTOMETRIC DETERMINATION OF DYSPROSIUM, HOLMIUM, ERBIUM, THULIUM, YTTRIUM, AND SCANDIUM BY THEIR RADIATION IN THE INNER CONE OF THE FLAME. Ovchar, L. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 22: 45-9(Jan. 1967). (In Russian).

The determination of rare earth elements by their radiation in the inner cone of an acetylene-air flame within the wave lengths from 400 to 420 μm was studied. Additional lines which were not excited in the external cone were found for dysprosium, holmium, erbium, thulium, yttrium, and scandium; their spectra did not overlap. A method was developed for determining dysprosium, holmium, erbium, and yttrium in a mixture of rare earth element oxides. The sensitivity of the determination of all the above-mentioned elements is 0.5% of Me_2O_3. (auth)

12417 CHEMICAL REACTIONS OF THE POSITRONIUM ATOM. Guetlbauer, Friedrich (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). Oesterr. Chem.-Zeit., 66: 381-7(1965). (In German).

The chemistry of positronium is reviewed. The physical properties of the positronium atom are given briefly, as well as its convenient production from ^{22}Na. The distinction between ortho and para positronium is made and some of the properties of each given, emphasizing the distinction between them. The Ore diagram for formation of positronium in air is illustrated. Stability of the species after formation in gases is given, and the fate of positrons in Ar is reviewed. The stability of positronium is used to emphasize distinctions between ortho and para isomers. The formation of ions in SF_6, ortho-para conversion in NO, and formation of positronium fluoride and chloride and of a compound with molecular O_2 are discussed. Some attention is devoted to the chemistry of positronium in aqueous and organic solutions and in solids. (BBB)

12418 CATALYTIC EXCHANGE AND DEUTERATION OF tert-BUTYLBENZENE AND p-tert-BUTYLTOLUENE ON EVAPORATED METAL FILMS. Harper, R. J. (Queen's Univ., Belfast); Siegel, S.; Kemball, C. J. Catalysis, 6: 72-81(Aug. 1966).

Catalytic exchange with D and deuteration of tert-butylbenzene were investigated on films of Pd, W, Pt, Ni, and sintered Ni using a mass spectrometer. The H atoms in the molecule could be divided according to their ease of exchange into groups of 3, 9, and 2, which are thought to be the ring atoms in the meta and para positions, the atoms on the side group, and finally the 2 ring atoms in the ortho positions. The bulky side group showed a pronounced steric deactivation on the reactivity of these last 2 atoms but its influence on the exchange of the other ring atoms or on deuteration was not nearly so great. The H atoms in the side group were replaced at rates comparable to those found for the exchange of neopentane and much lower than the rates of exchange of H atoms on the β carbon atoms of molecules like ethylbenzene and cumene. Some observations on the exchange and deuteration of p-tert-butyltoluene on films of Ni and W were also made. The results of this investigation are discussed with emphasis on the differences between the mechanism of the heterogeneous metal-catalyzed exchange and the homogeneous acid-catalyzed exchange reactions of the alkylbenzenes. However, the same reaction path may not operate for ring exchange on all metals and there is some evidence that suggests that W may differ from the other metals and may, possibly, involve a dissociative mechanism. (BBB)

12419 OXYGEN ION CONDUCTING SOLID ELECTROLYTES AND POSSIBILITIES FOR THEIR APPLICATION: ON THE INFLUENCE OF THE ELECTRODE MATERIAL ON THE RESULT OF MEASUREMENTS OF THE ELECTRICAL CONDUCTIVITY OF SOLID ELECTROLYTES. Moebius, H.-H.; Rohland, B. (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Chem., 6: 158-9(1966). (In German).

In addition to studies with electrode layers of Pt, Ag, and Ni on sintered Nernst mixture (85% ZrO_2–15% Y_2O_3), the effect of using a U_3O_8–Pt electrode layer on measured values of conductivity was studied. Measurements were made in air and in CO/CO_2 mixtures. While dependence of the measured values on atmosphere composition was considerable for the Ag and Pt electrodes, it was not apparent for the U_3O_8/Pt electrode when measurements were made at 50 cycles. The temperature dependence was found to be strictly in inverse relation; values of conductivity were higher for the U_3O_8-Pt electrode than for the others tested under the same conditions. At 800°C the current density with the U_3O_8-Pt electrode was linear with voltage between 0 and 1.2 V; the sensitivity of current density to voltage of this electrode was exceeded only by that of the Ag electrode in air, although the latter was much less sensitive to voltage in CO/CO_2. Polarization effects are minimized with the U_3O_8-Pt electrode. (BBB)

12420 INTERMEDIATE STEPS IN AUTOXIDATIONS. II. AUTOXIDATION AND ENOLIZATION OF ACETOPHENONE IN ACETIC ACID. Den Hertog, H. J. Jr. (Technical Univ. of Twente, Enschede, Netherlands); Kooyman, E. C. J. Catalysis, 6: 357-61(Dec. 1966).

The Mn-catalyzed autoxidation (110°C, 1 atm of oxygen) of acetophenone (<0.7 M) in CH_3COOD as well as of acetophenone-ω-d_3, in CH_3COOH proceeded at the same rates as the H/D exchange under the same conditions but in the absence of oxygen. In both oxidation reactions, the unoxidized ketones retained their isotopic compositions. Moreover, substituent effects on autoxidations of acetophenones were the same as observed for H/D exchange ($\rho = -0.7$). These data provided evidence for enolization being the rate-determining step in these autoxidations. Arrhenius energies of activation were ~15 kcal for autoxidation as well as for deuteration of acetophenone. At higher concentrations, however, autoxidation rates fell below rates of H/D exchange; the unoxidized acetophenones showed isotopic exchange. In these systems, reduction of Mn^{3+} by the enol is probably so fast that its regeneration from Mn^{2+} becomes (partly) rate-determining. H/D isotope effects were small in changing the solvent from CH_3COOH to CH_3COOD, rates decreasing by a factor of 1.2 at 110°C. However, $C_6H_5COCD_3$ was oxidized in acetic acid at $\frac{1}{3}$ the rate of acetophenone. (BBB)

12421 VIRIAL COEFFICIENTS OF INERT AND ASSOCIATED GASES IN THE LOW TEMPERATURE REGION. Skripka, V. G. Tr. Vses. Nauch.-Issled. Inst. Kislorod. Mashinostr., No. 10, 163-83(1965). (In Russian).

Using data from 46, mostly Western, references, the second virial coefficients of oxygen, nitrogen, argon, helium, neon, hydrogen, deuterium, and krypton are evaluated at temperatures in

the 10 to 150°K range. Following a brief outline of the method for calculation of the virial coefficients of pure gases and mixtures, a summary of the various data used is presented, and each of the equations used for the determination of the temperature variations of the second virial coefficients under study are discussed at length. The results are summarized in tabular form. Use of the law of corresponding states for the determination of the virial coefficients of pure gases is discussed. (JPRS)

12422 THE INFRARED SPECTRA OF C_2H_2 AND C_2D_2: AN EXPERIMENT ON MOLECULAR STRUCTURE AND SYMMETRY. Richards, L. Willard (Cabot Corp., Billerica, Mass.). J. Chem. Educ., 43: 644-7(Dec. 1966).

Procedures are described for obtaining and analyzing the near-ir absorption spectra of C_2H_2 and C_2D_2. The rotational lines in each band show a marked intensity alternation due to the molecular symmetry. By calculation of the rotational constants for the 2 isotopically different molecules, enough data is obtained to solve for the C=C and C—H bond lengths. Reasons are cited for choosing the $\nu_1 + \nu_3$ bands of acetylene for this experiment. The spectra obtained showed an intensity alternation due to the different statistical weights of the rotational levels with odd and even values of J, and the odd levels are favored in C_2H_2 while the even levels are favored in C_2D_2. By use of a least squares fit of a cubic equation to the spectra, rotational constants were calculated in the ground vibrational state of 1.1742 cm^{-1} for C_2H_2 and 0.8478 cm^{-1} for C_2D_2. These were compared with recent values of 1.17654 ± 0.00004 cm^{-1} and 0.84794 ± 0.00005 cm^{-1}. The rotational constants obtained led to bond lengths of $r_{a_{CC}}$ = 1.213 Å and $r_{a_{CH}}$ = 1.055 Å, which were within 0.5% of the recent values of 1.2088 ± 0.0002 and 1.0566 ± 0.0003 Å. (BBB)

12423 SOME MEASUREMENTS ON THE QUANTUM YIELD TEMPERATURE COEFFICIENT OF THE URANYL OXALATE ACTINOMETER AT 254 mμ. Norton, B. M. (Kenyon Coll., Gambier, Ohio). Ohio J. Sci., 66: 421-5(July 1966).

Ultraviolet photolysis of uranyl oxalate was studied. For solutions of 0.001M uranyl sulfate and 0.005M oxalic acid, a 10° temperature coefficient, up to 85°C (using a base temperature of 25°C) of 1.02 ± 0.01 moles/einstein at 254 mμ was found. Measurements in more dilute solutions showed a decrease to ~unity at 0.00025M uranyl sulfate—0.00125M oxalic acid, with indication that it may become less than unity on further dilution. In a discussion of the equilibria involving formation of photosensitive complexes made up of the uranyl ion with oxalic acid and oxalate ion, it is suggested that the variations found in the results may be ascribable to shifts in the concentration of photosensitive complexes. Hydrolysis may be a factor at high temperatures, and formation of U(IV) may also be a factor. A light greenish precipitate was observed during runs close to the boiling point of the solution, while samples of the same solution boiled for the same time in the dark produced no such effect. (BBB)

12424 DEUTERATION AND DEUTEROGENATION OF NAPHTHALENE AND TWO OCTALINS. Weitkamp, A. W. (American Oil Co., Whiting, Ind.). J. Catalysis, 6: 431-57(Dec. 1966).

Saturation of napthalene on a Group VIII metal yields trans-decalin by cis addition of hydrogen to an appropriate octalin intermediate rather than by direct trans addition. In like manner, dihydronaphthalene may be an intermediate in the formation of tetralin but with less obvious stereochemical consequences. Treatment of naphthalene and the two stereochemically significant octalins with deuterium gave evidence of a series of steps wherein exchange (deuteration) may be separate from or accompany saturation (deuterogenation). The mechanism of exchange on the aromatic ring or about the double bond seemed to be largely dissociative with Pt and Ir, partly associative with Pd, and in-between with Ru and Rh. Saturation, accompanied by exchange and double-bond isomerization, and the exchange accompanying the double-bond shift seemed to conform to the classical Horiuti-Polanyi associative mechanism. The dissociative process was retarded by increased pressure and accelerated by increased temperature. The isomerized olefin that would establish dissociative reversal from the half-hydrogenated state was detected at elevated temperatures on Pd and Rh catalysts. Release of intermediates from the surface by desorption may be complete enough to achieve exchange or isomerization, but not always complete enough for flipover. Diffusion effects may be significant. Large differences in selectivities of the Group VIII metals may not necessarily reflect differences in mechanisms but rather in relative rates of otherwise identical steps in a complicated sequence. (BBB)

12425 THE HYDROGENATION OF ACETYLENE. IV. THE REACTION OF ACETYLENE WITH DEUTERIUM CATALYZED BY ALUMINA-SUPPORTED RHODIUM, PALLADIUM, IRIDIUM, AND PLATINUM. Bond, G. C.; Wells, P. B. (Univ. of Hull, Eng.). J. Catalysis, 6: 397-410(Dec. 1966).

The reaction of acetylene with D was studied using alumina-supported Rh (134 to 200°C), Pd (0 to 46°C), Ir (30 to 120°C), and Pt (50 to 110°C). Products were analyzed by mass and ir spectrometry. No acetylene exchange was observed; H-D exchange was fairly rapid over Rh and Ir, slow over Pt, and negligible over Pd. All possible isotopic ethylenes were formed. Ethylene-d_2 was usually most abundant, but its yield varied from metal to metal (Pt > Pd > Ir > Rh), and over each metal the fraction that is formed of the total ethylene yield increased with increasing initial D_2 pressure and fell with increasing temperature. When the yield of ethylene-d_2 was high (as over Pd and Pt) its major component was the cis isomer, and the concentration of the asymmetric isomer was low (<4%), but when the yield of ethylene-d_2 was low (Rh), cis- and trans-ethylene-d_2 were formed in about equal proportions, and the concentration of the asymmetric isomer was considerable (10–15%). The ethylene distributions were interpreted in terms of a simple theoretical scheme. Two parameters s and p defined the chances of adsorbed species acquiring D (or H) atoms and of vinyl groups undergoing hydrogenation (or dehydrogenation). Each parameter was assigned a numerical value for each experiment by the interpolation procedure described. The change of adsorbed species acquiring a D atom rather than a H atom was shown to be high over each metal, but the chance of vinyl undergoing hydrogenation rather than dehydrogenation is high over Pt and Pd, low over Rh, and intermediate over Ir. (BBB)

12426 GENERATION OF NEW INFRARED MASER FREQUENCIES BY ISOTOPIC SUBSTITUTION. McCurdy, G. B.; Wieder, I. (Carver Corp., Mountain View, Calif.). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 385-7(Sept. 1966).

Experiments in which ^{18}O was substituted for ^{16}O in the CO_2 ir maser are reported and some possible applications of this technique are noted. The effect of isotopic substitution on the characteristic vibrational and rotational frequencies of diatomic and triatomic molecules is discussed, and it is shown how this effect may be used to generate new maser frequencies in the ir, which differ significantly from those obtained in the original molecule. The magnitude of this effect, in which the ratio of the original frequency to the isotopically shifted frequency may be as great as 1.4 in one case considered, is contrasted with the corresponding isotope effect on the frequency of electronic transitions in atoms, where the shift in frequency thus obtained is extremely small, typically amounting to one part in 10^4. The calculated effect of the isotope shift on the frequencies of 2 known diatomic molecular infrared masers is given for selected isotopes. The results of an experiment in which ^{18}O was substituted for ^{16}O provide an example of the isotope effect on a triatomic molecule. It was found that the dominant 10.6-μ maser transition in $^{12}C^{16}O_2$ is shifted to 9.4 μ while the 9.5-μ transition is shifted to 10.4 μ as a result of double substitution of ^{18}O for ^{16}O in the CO_2 molecule. (BBB)

12427 INTERMEDIATE STEPS IN AUTOXIDATIONS. I. ENOLIZATION AND DEUTERATION OF ACETOPHENONES IN ACETIC ACID. Den Hertog, H. J. Jr. (Technical Univ. of Twente, Enschede, Netherlands); Kooyman, E. C. J. Catalysis, 6: 347-56(Dec. 1966).

Enolization of acetophenones in acetic acid, followed by the determination of H/D exchange with the solvent, is reported. With acetic acid-d as a solvent, rates of deuteration, presumed to be identical with rates of enolization, were determined by NMR analyses. The nuclear protons do not exchange and served as the internal standard for methyl protons. Substituent effects were expressed in terms of a Hammett rho-sigma relation, with $\rho = -0.7$ at 110°C andusing constants proposed by Brown and Okamoto. For acetophenone, the Arrhenius activation energy (65 to 120°C) amounted to 16 kcal. The reactions were first order with respect to the ketones. Sodium acetate and pyridine showed a marked accelerating effect on H/D exchange rates, which were proportional to the amount of base. Base-catalyzed contributions to rate constants could be represented by a Hammett-type equation, with ρ = 0.7. Presumably, deuteration in the absence of base constitutes a true measure of enolization rates, i.e., it occurs through the enol, formed in a two-step process; base catalysis is attributable to reversible proton removal from the ketone. (BBB)

12428 ON ANOMALOUS BEHAVIORS OF BODY-CENTERED TETRAGONAL $ThCl_4$ AT HIGHER TEMPERATURE. STUDY ON PROPERTIES OF THORIUM CHLORIDE (1). Takeuchi, Sakae (Tohoku Univ., Sendai); Obata, Naomi. Nippon Kinzoku Gakkaishi, 30: 941-6(Oct. 1966). (In Japanese).

Properties of $ThCl_4$ were studied by means of x-ray powder diffraction, pressure measurement by the Burdon gauge, and gravimetric analysis by a thermobalance. To protect the hygroscopic chloride from hydration, all samples were treated in dry atmosphere. The x-ray pattern of $ThCl_4$ powder prepared by

chlorination showed a body-centered tetragonal type, in good agreement with the known structure as anhydrous chloride. But in the case of the vapor pressure measurement below 900°C, a markedly irreversible change in pressure was observed on heating and cooling, and retained gas of considerable pressure was found even at room temperature. On gravimetric analysis of tetrachloride in vacuum, a weight loss of 6 to 10% was seen below 400°C, where sublimation of chloride was scarcely observed. After sublimation proceeded above 500°C, the weight loss finally ceased, and an insoluble residue was formed. Moreover, the gas release of H_2O and HCl, and the formation of $ThOCl_2$ and ThO_2 were confirmed in the course of heating the $ThCl_4$ powder in vacuum. From the above results it seems evident that body-centered tetragonal $ThCl_4$ is not of the anhydrous but the hydrated phase containing a considerable amount of H_2O in the crystalline state. Anomalous behaviors of $ThCl_4$ can be attributed to dehydration and hydrolysis. In the course of studies, the phase $ThOCl_2$ was identified and its x-ray diffraction data was established. (NSA of Japan)

12429 ON THE NEW PHASE OF THORIUM TETRACHLORIDE. STUDY ON PROPERTIES OF THORIUM CHLORIDE (2). Takeuchi, Sakae (Tohoku Univ., Sendai); Obata, Naomi. Nippon Kinzoku Gakkaishi, 30: 946-52(Oct, 1966). (In Japanese).

Vacuum sublimation of $ThCl_4$ was carried out in order to prepare the anhydrous chloride. Properties of the sublimation product and the process conditions were also investigated. According to the chemical analysis and melting point measurement, the product was undoubtedly $ThCl_4$, but the x-ray diffraction pattern was quite different from that of the body-centered tetragonal structure formerly confirmed as the crystal structure of $ThCl_4$. Results of present work proved that the known tetragonal phase $ThCl_4$(I) may be regarded as hydrated chloride, and the newly found $ThCl_4$(II) to be anhydrous chloride. On vacuum heating of $ThCl_4$(I), gas is released and solid residue is formed due to dehydration and hydrolysis. $ThCl_4$(II) was free from such a behavior. In spite of vacuum sublimation, the product was again $ThCl_4$(I) if the released gas from the starting chloride was not effectively evacuated. $ThCl_4$(II) could only be prepared by vacuum sublimation under a highly dried atmosphere. The diffraction data of $ThCl_4$(II) suggested its crystal structure to be of the orthorhombic system. The lattice constants obtained were a = 11.18Å, b = 5.93Å and c = 9.09Å. The tetragonal data previously known was obtained by using samples prepared by sublimation in a glass capillary, where a highly dried atmosphere could hardly be attained and probably the product was nothing but hydrated $ThCl_4$(I). (NSA of Japan)

12430 MEASUREMENT OF SLOW PROTON TRANSFERS. Wallick, Earl Taylor. Houston, Tex., Rice Univ., 1966. 50p.

Thesis.

A radioactive labeling technique was used to study the sodium acetate catalyzed bromination of 2-methylbutyrophenone. The label was placed in the γ position. The radioactive impurity, butyrophenone-4-t, which differs greatly in specific activity from the main component, was removed by means of the "hold-back carrier" technique. Essentially, this involves diluting the radioactive impurity, butyrophenone-4-t with inactive butyrophenone. The 2-methylbutyrophenone, RH, is then repurified, and although some of the butyrophenone remains in the product, its activity is isotopically diluted. The mechanism for the base catalyzed bromination of ketones for a long time exhibits first-order dependence on the concentration of base and ketone but zero-order dependence on the concentration of bromine. The rate-controlling step was shown to be the formation of the enolate ion. For small extents of reaction, the rate law may be written as $[RBr]/[RBr]_\infty = kt$ = extent of reaction, where [RBr] is 2-bromo-2-methylbutyrophenone. The actual quantities measured were specific activities instead of concentrations, but the activity ratio is the same as the concentration ratio. The reactions were followed to 0.2 to 2% of completion. The procedure for measurement of the extent of reaction involves reacting a measured amount of RH for a measured time interval, diluting the reaction product with a carrier (inactive RBr) and purifying the RBr from the radioactive RH by means of the "hold-back carrier" technique. The rate constants and isotope effects are given below.

	$k_H \times 10^8$ sec^{-1}	$k_D \times 10^8$ sec^{-1}	k_H/k_D*
32.10°	3.53	0.458	8.3
48.50°	9.86	1.47	7.1
78.9°	146.7	23.8	6.5

*Corrected for 1% protium contamination.
(Dissertation Abstr.)

12431 THULIUM COMPOUND WITH A LOWER OXIDATION STATE. PART I. PREPARATION OF A THULIUM COMPOUND WITH A LOWER OXIDATION STATE. PART II. SOME PRELIMINARY STUDIES WITH SAMARIUM, THULIUM, AND YTTERBIUM. Schnepfe, Marian Moeller. Washington, D. C.; George Washington Univ., 1966. 105p.

Thesis.

A thulium compound with definite reducing properties was prepared by the reaction of metallic Tm with hydrochloric acid. Owing to the tendency of the compound to ignite explosively when heated and to liberate hydrogen when thermally decomposed, it is assumed that this compound contains hydridic hydrogen. Because no single approach could be expected to reveal the exact nature of the synthetic compound, it was investigated along a number of lines. These include chemical, mass spectrometric, thermogravimetric, and differential thermal analyses; absorption spectra; and x-ray diffraction studies. The chemical analysis, the oxidation-reduction reactions, and the infrared absorption spectra studies suggest the following formula: $(H_{0.7}Cl_{0.3})Tm_2O.2H_2O$. The thulium may be considered to exist in the sesquivalent state, or to exist both in the monovalent and divalent state in single "molecules" of the compound, or even to occur in the monovalent and divalent state in separate "molecules." Consideration of the broad absorption bands in the 8 to 14 μ range might suggest only divalent thulium ions associated with free electrons as part of a general lattice; the compound could possibly be formulated as $(H_{0.7}Cl_{0.3})^-Tm^{++}{}_2O = \epsilon^-.2H_2O$. Magnetic susceptibility data indicate that metallic Tm and the trivalent thulium have the same magnetic moment; intermediate oxidation states can be expected to have a similar magnetic moment. Within experimental error this expectation was realized. An anion with reducing properties tends to stabilize a lower valence state. However, the assignment of the reducing properties to the Tm, rather than an anion, cannot be made with absolute certainty by chemical means. A structure is proposed that accounts for all the observed properties of this compound. While the structure is compatible with the observed properties, this investigation does not rule out other possibilities. A final proof of the atomic arrangement and oxidation states depends on additional physical measurements. Such measurements might well include neutron diffraction for the assignment of exact atomic positions and the Mössbauer effect for determination of the oxidation state of the Tm. Electric conductivity measurements might possibly indicate the presence of free electrons in the lattice. (Dissertation Abstr.)

12432 PREPARATION OF AQUASOLS OF CRYSTALLINE ZIRCONIA AND/OR HAFNIA. Fitch, Frederick T.; Smith, Jean G. (to W. R. Grace and Co.). U. S. Patent 3,282,857. Nov. 1, 1966. Filed Dec. 21, 1962.

A method is described for preparing aquasols of crystalline particles of the oxides of Zr, Hf, or a mixture of the two oxides by preparing an aqueous basic salt of the element(s), electrodialyzing the salt solution to prepare a sol of amorphous particles in the 3- to 7-mμ size range, heating the sol in a closed vessel at a temperature of 100 to 200°C for about 1 to 40 hr to insure particle growth and crystallization, cooling the sol, deionizing, concentrating to about 10 to 30% solids, and recovering the product sol. Deionizing of the sol can be carried out by contacting the product sol with a weak anion exchange resin prior to concentration by centrifugation. (B.L.M.)

12433 PROCESS FOR PREPARING URANOUS OXIDE SOLS. Smith, Jean G.; Fitch, Frederick T. (to W. R. Grace and Co.). U. S. Patent 3,281,373. Oct. 25, 1966. Filed Feb. 28, 1962.

A method is described for the preparation of UO_2 sols from uranous oxychloride solution obtained by dissolving uranyl chloride in an aqueous medium and reducing the solution. The uranous oxychloride solution (preferred concentration of 5 g/100 ml) is autoclaved in an inert or reducing atmosphere at a temperature of 100 to 200°C for a period of 2 to 40 hr. The autoclave is then cooled, and the product is removed as a solid that is dispersed to a brown or black sol when the supernatant liquor containing the bulk of the electrolyte is removed by centrifugation or decantation and is replaced by deionized water to disperse the UO_2 particles to form a stable sol containing up to 30 wt % solids. The particles of the sol so prepared are roughly spherical or cubic aggregates ranging up to 300 mμ in diameter. (B.L.M.)

12434 METHOD FOR PREPARING PHOSPHORS AND PRODUCTS THEREOF. (to Radio Corp. of America). British Patent 1,052,304. Dec. 21, 1966. Priority date May 20, 1963, United States.

A luminescent material exhibiting a narrow emission peak at a wavelength in the range from 4700 to 5800 Å was prepared by reacting chalcogenides of Zn, Cd, or Zn–Cd with 0.001 to 5.0 mole % of a halide of Pr, Tb, Dy, Ho, Er, or Tm and up to 1.0 mole % of a Cu halide in an ambient free of oxygen and oxygen-containing materials. The reaction was carried out at temperatures in the range from 700 to 1400°C, and a reaction time ranging from 0.1 to 10 hours may be required. (B.L.M.)

12435 A METHOD OF PRODUCING FLUORIDES OF RARE EARTH METALS AND/OR OF THORIUM. (to Th. Goldschmidt A. G.). British Patent 1,051,618. Dec. 14, 1966. Priority date Oct. 9, 1962, Germany.

A method for producing rare earth and/or Th fluorides consists of reacting as aqueous suspension of a difficultly soluble compound of the rare earth and/or Th in an acidified aqueous medium (pH < 4) with an alkaline earth metal fluoride that is more readily soluble than the fluorides of the rare earth metals and/or Th. The reaction is carried out at a temperature between 60 and 100°C. (B.L.M.)

12436 IMPROVEMENTS IN OR RELATING TO THE OXIDATION OF PLUTONIUM COMPOUNDS. Bouzou, Monique; Deroite, Andre (to Commissariat a l'Energie Atomique). British Patent 1,052,895. Dec. 30, 1966. Priority date Apr. 9, 1963, France.

A method is described for the oxidation of Pu (III) to Pu(IV) using nitrous vapors formed by reacting hot nitric acid with formaldehyde or by reacting nitric acid with Fe or Cu in the metallic state. The oxidation can be carried out in nitric acid, sulfuric acid, or mixtures of these two acids. (B.L.M.)

12437 IMPROVEMENTS IN OR RELATING TO ELECTRO-DEIONISATION. Gittens, Gerald James (to United Kingdom Atomic Energy Authority). British Patent 1,050,960. Dec. 14, 1966. Filed Nov. 25, 1964.

A method and apparatus are provided for the electrodeionization of a solution by passing the solution through a deionization compartment of a multicomponent electrodeionization cell containing a mixed bed of cation and anion exchange resins. The specific electrical conductivities of the cation and anion exchange resins are essentially the same, but the degree of crosslinking of the resins is different. Preferably, the cation exchange resin is crosslinked with 8 wt % of divinyl benzene and the anion exchange resin is crosslinked with 2.5 wt % of divinyl benzene. (B.L.M.)

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Refer also to abstracts 12489, 13411, and 13744.

12438 (BNL-50017) O_3 AND NO_2 FORMATION BY IRRADIATION OF A N_2-O_2 GAS MIXTURE IN A FLOWING SYSTEM AT ELEVATED PRESSURES. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Sept. 1966. Contract AT-30-2-GEN-16. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of operating a flow system constructed of stainless steel with a 79% N_2 + 21% O_2 gas mixture in a ^{60}Co gamma field at an intensity of 675,000 RADS/hr, indicate that at 68 atm and 30°C a maximum $G(NO_2)$ value of 1.18 at a concentration of 89 ppM NO_2 is obtained. Only NO_2 can be detected for residence times equivalent to doses above 1.35 MRAD. At higher flow rates and thus shorter residence times, the NO_2 concentration and yield decreased and O_3 began to appear. A $G(O_3)$ value of 4.68 at an O_3 concentration of 22 ppM was reached. Below a residence time equivalent to a dose of 400,000 RADS, only O_3 was present with the NO_2 decreasing to below detectable limits. Increasing the pressure from 68 to 680 atm appeared to have a small decreasing effect on the NO_2 yield and a larger increasing effect on the O_3 yield. (auth)

12439 (COO-1167-1) NUCLEAR CHEMISTRY RESEARCH. Technical Progress Report, December 15, 1965-December 15, 1966. Sugarman, Nathan; Turkevich, Anthony (Chicago Univ., Ill.). Contract AT(11-1)-1167. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: computations and experiments on internuclear cascades in a solid body; radionuclide production cross sections in Cu with 90- to 440-MeV protons; radiochemical analysis of freshly fallen meteorites; meson spallation of Cu; recoil properties of isobaric nuclides; angular distribution of fragments from nuclear reactions; activation analysis for heavy elements in meteorites; and recoil properties of isomeric nuclides. (P.C.H.)

12440 (LA-DC-8152) SYNTHESIS OF HEAVY ELEMENTS BY MULTIPLE NEUTRON CAPTURE. Cowan, G. A. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 6p. (CONF-661035-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Heavy Ion Physics, Dubna, USSR.

The synthesis of fermium isotopes by prompt multiple neutron capture experiments is discussed. As a result of these experiments, and with respect to possible improvements in neutron flux, it is predicted that, unless the instability of very heavy nuclei forbid it, the integrated neutron flux can be increased sufficiently to produce detectible quantities of nuclides at least ten mass units higher than have presently been made. (P.C.H.)

12441 (N-66-24981) POLYMER DECOMPOSITION INITIATED BY HIGH-ENERGY RADIATION. Progress Report, November 1965-May 1966. Wall, Leo A. (National Bureau of Standards, Washington, D. C.). Apr. 1966. 10p. (NASA-CR-74662). CFSTI $3.00 cy, $0.65 mn.

A study of the gamma ray initiated thermal depolymerization of polytetrafluoroethylene showed that the mechanism consists of random initiation, termination by combination, and the kinetic chain lengths are short. In considering the thermal decomposition of anionically prepared polymers of 1,2-dihydronaphthalene, it was found that the polymer was only slightly better than polystyrene, and unlike polystrene, appeared to decompose exothermically. (STAR)

12442 (NYO-2383-16) STUDIES OF THE RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. Progress Report for February 1-December 15, 1966. Lichtin, Norman N. (Boston Univ., Mass.). Jan. 5, 1967. Contract AT(30-1)-2383. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on effects of acid on gamma radiolysis of deuterated methanol and radiolytic configurational isomerization of stilbene in methanol solution. (P.C.H.)

12443 (ORNL-P-2554) RADIATION-INDUCED CODIMERIZATION OF ETHER-UNSATURATE MIXTURES. Bopp, C. D.; Parkinson, W. W. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 5p. (CONF-660941-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 6th Annual Contractors Meeting for the Process Radiation Development Program, Washington, D. C.

The radioinduced codimerization of cyclic ethers with unsaturated compounds was studied. The products were tentatively identified by comparison of their gas chromatographic retention times with those of authentic compounds which were synthesized for this purpose. In order to determine the most favorable reaction conditions with cyclohexene-tetrahydrofuran mixtures the effects of composition, temperature, dose rate, and purity were examined. The principal products found by gas chromatography were cyclohexenyltetrahydrofuran, cyclohexyldihydrofuran, tetrahydrodifuryl, octahydrodifuryl, and dicyclohexenyl. The overall yield of products of low volatility including polymer was G = 18 at 25°C (determined by evaporation in vacuum). Although the yields of certain of the products were increased at high temperature, very high yields of codimers were not achieved. (auth)

12444 (NP-tr-1480) A PRACTICAL COURSE IN RADIATION CHEMISTRY. Bugaenko, L. T.; Kalyazin, E. P.; Saraeva, V. V. Translated by J. M. Crabtree and J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from pp 2-162 of Praktikum po Radiatsionnoi Khimii, Izd. Mosk. Gos. Univ. im M. V. Lomonosova, Moscow, 1962. 147p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $11.00 fs, $4.61 mf.

A collection of experiments on the basic aspects of radiation chemistry is presented, involving the use of x-ray apparatus as a source of ionising radiation, although ^{60}Co gamma radiation may be used with appropriate changes in irradiation conditions. Topics covered include: dosimetry in radiation chemistry, radiation chemical changes in aqueous solutions, aqueous solutions of organic substances, radiolysis of organic compounds, radiation-chemical oxidation of organic compounds, and radiation chemistry of polymers. (UK)

12445 (UCRL-Trans-10085) STRUCTURE AND PROPERTIES OF LITHIUM FLUORIDE IRRADIATED WITH NEUTRONS AT LOW TEMPERATURES. Lambert, M.; Guinier, A. Translated by Z. F. St-Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from J. Phys. (Paris), 24: 552-60(1963). 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $3.60 fs, $1.25 mf.

Lithium fluoride monocrystals were irradiated with neutrons at -195°C and then heated to room temperature. The defects found in these crystals differed in nature from, and were more numerous than, the defects in crystals irradiated at the reactor temperature (ca. 150°C). The number of defects was estimated from the change in the density. To produce these different defects, the irradiation temperature must be lower than -12°C. After irradiation at -195°C, the difference in the nature and number of defects (from those associated with high-temperature irradiation) was destroyed only when the crystals were subsequently heated to 325°C. (auth)

12446 REACTIONS OF THE HYDROXYL RADICAL IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF DI-ETHYL ACETAL. Basson, R. A.; Champion, P. M. (Atomic Energy Board, Pretoria). Nature, 211: 1398-9(Sept. 24, 1966).

A study of the reaction between hydroxyl radicals produced by the photolysis of hydrogen peroxide and acetal was made. Solutions of acetal and hydrogen peroxide were irradiated with a low-

pressure mercury lamp. The main products of the photolysis were ethanol and acetaldehyde together with a small amount of diethyl ether. Other reactions leading to the same products were observed. Hydrolysis took place even at pH 7 and reaction between acetal and hydrogen peroxide was found. It was strongly indicated that in the radiolysis of aqueous acetal the formation of acetaldehyde is partly due to reaction between acetal and either the hydroxyl or the peroxyl radical. Because of competition on the part of the products it could not be ascertained whether this is the only effect or whether hydrolysis induced by radiation and catalyzed by acid contributed to the formation of the products. (D.H.M.)

12447 RADIATION CHEMISTRY OF DIHYDROMYRCENE. Brash, J. L.; Golub, M. A. (Stanford Research Inst., Menlo Park, Calif.). Can. J. Chem., 45: 101-8(Jan. 15, 1967).

Dihydromyrcene was irradiated with 1-MeV electrons at room temperature both in the pure state and in benzene solution. The main reactions observed, and their G-values for the pure diisoprene, were loss of unsaturation (~7.8 to 9.9), crosslinking (or dimerization) (2.4 to 2.6), evolution of hydrogen (0.81), and trans → cis isomerization (<0.5). As with squalene, the loss of double bonds in dihydromyrcene occurred only in the crosslinked residue obtained on distillation of the irradiated isoprenoid. Although the residue (mainly dimer, with some trimer) was considered to be partially cyclized, no cyclization of uncrosslinked (monomeric) dihydromyrcene was observed. Dihydromyrcene in 10% benzene solution (by weight) showed trans → cis and cis → trans isomerization with G-values of 0.63 and 1.2, respectively, hydrogen evolution with a G-value of 0.08, and a higher rate of loss of original unsaturation than in the pure state. (auth)

12448 RADIOLYSIS OF AQUEOUS SOLUTIONS OF DIGLYCINE. PART I. SPECTROPHOTOMETRIC STUDY OF COPPER BIURET COMPLEX AND CARBONYL GROUPS WITH PARTICULAR REGARD TO PEPTIDE BOND RUPTURE. Kang, Man Sik. Kisul Yon Guso Pogo, 4: 46-9(1965).

Spectrophotometric studies were made on peptide bond rupture and carbonyl group formation in gamma-irradiated diglycine. The peptide bond was broken in direct proportion to dose up to 1×10^6 RAD and the rate of bond rupture decreased at a dose of 1×10^7 RAD indicating successful competition of the products for the free radicals, with a corresponding reduction in the number of diglycine molecules reacting. Initial G-value for the peptide bond rupture was determined to be 2.0 and that of carbonyl production was about 1. (auth)

12449 IRRADIATED POLYETHYLENE. II. FREE RADICAL FORMATION. Auerbach, I. (Sandia Lab., Albuquerque, N. Mex.). Polymer, 8: 63-77(Feb. 1967).

Allyl free radical formation in Marlex 50 polyethylene at room temperature is correlated with vinyl group disappearance and vinylene group formation. The allyl radicals were generated with 2-MeV electrons from a Van de Graaff accelerator and their concentrations were measured with electron spin resonance techniques. A kinetic analysis of the free radical formation and vinyl disappearance data provide a mechanism for these reactions. The mechanism assumed the formation of a steady-state concentration of positive alkyl ions, which were formed initially, followed by charge transfer to vinyl and vinylene groups. A subsequent reaction between the vinyl ion and a neutral vinyl group took place. The resultant divinyl and vinylene ions formed allyl radicals following charge recombination. Kinetic equations derived from this mechanism correlated well with experimental data. The G value for alkyl ion formation calculated from these equations was the same as that obtained for radical formation in lower molecular weight hydrocarbons and for alkyl radical formation in polyethylene at 77°K and at low doses. This G value also correlated with the G values for the polymerization of olefins. The kinetic data provide evidence that allyl radical formation did not take place through a precursor alkyl radical. (auth)

12450 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XVIII. INVESTIGATION OF THE MONOALLYL ESTER OF NORBORNENEDICARBOXYLIC ACID AND ITS TWO-COMPONENT SYSTEMS. Hardy, Gyula; Nyitrai, Karoly (Mueanyagipari Kutato Intezet, Budapest). Magyar Kem. Foly., 72: 522-5(Dec. 1966). (In Hungarian).

The solid state polymerization of norbornenedicarboxylic monoallyl ester has been investigated. The polymerization proceeds by the reaction of the allylic bonds up to 20% conversion; above this limit an insoluble polymer is obtained as a result of the reaction of the double bonds of the ring. The two-component system of norbornenedicarboxylic monoallyl and monopropyl ester exists as an isomorphous solid solution. The propyl ester acts as a physical barrier in the solid state polymerization of the allyl ester and increasing the concentration of the propyl ester results in a monotonous decrease of the rate of polymerization. The two-component systems of monoallyl ester with acetanilide, succinimide, and naphthalene are characterized by the formation of eutectic compositions. The characteristics of the solid state polymerization in these two-component systems indicate the formation of quasi-eutectic structures, i.e., the physical structures of these solid systems depend very much on the conditions of cooling and crystallization. (auth)

12451 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XVII. POLYMERIZATION AND COPOLYMERIZATION OF 5-CARBOXY-BICYCLO-[2,2,1]-HEPTENE-(2) WITH MALEIC ANHYDRIDE. Hardy, Gyula; Nyitrai, Karoly; Sarlo, Csaba (Mueanyagipari Kutato Intezet, Budapest). Magyar Kem. Foly., 72: 517-22(Dec. 1966). (In Hungarian).

Radioinduced liquid and solid state polymerization of 5-carboxy-bicyclo-[2.2.1]heptene-(2) and the copolymerization reactions with maleic anhydride have been investigated and the structures of the polymers studied. The kinetics of the polymerization and copolymerization processes have linear character, and the rate of the solid state polymerization indicates a maximum value at 30°, 10° below the melting point, where a second order transition point exists. There is a eutectic composition in the two-component solid system; the rate of the copolymerization changes accordingly, and the composition of the obtained copolymers indicate a very high rate of self-addition of maleic anhydride. (auth)

12452 INVESTIGATIONS ON UV- AND X-IRRADIATED WATER. Ander, Sabine (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Strahlentherapie, 132: 135-42(Jan. 1967). (In German).

Pulsed x-irradiation of highly purified, oxygen-containing water, produced a reversible increase in conductivity, which almost disappeared in oxygen-deficient water. Its value was inversely proportional to the CO_2 concentration. From the results it was concluded that the hydroperoxyradical, O_2^-, is the charge carrier, which disappears by recombination reactions with other O_2^- radicals and by reacting with other O_2^- radicals and by reacting with the dissolved CO_2. (auth)

12453 RADIATION CHEMISTRY OF CHLORINE OXIDE COMPOUNDS. V. EPR METHOD OF INVESTIGATION OF RADIOLYSIS OF PERCHLORIC ACID AQUEOUS SOLUTIONS. Belevskii, V. N.; Bugaenko, L. T. (Moscow State Univ.). Zh. Fiz. Khim., 41: 144-51(Jan. 1967). (In Russian).

An analysis of radiochemical transformations in solidified 1 to 12.5M $HClO_4$ aqueous solutions irradiated with ^{60}CO γ rays at –76 and –196°C revealed ClO_3^- and Cl^- ions as the stable products, and H atoms and OH, HO_2, ClO_2, and ClO_3 as the radical products formed during radiolysis. Mutual transformation of heated radicals and reactions between thermalyzed electron and non-dissociated $HClO_4$ were studied. Radiolytic mechanisms are discussed. (R.V.J.)

12454 RADIOLYSIS OF CYSTINE IN AQUEOUS SOLUTION BY GAMMA IRRADIATION. Rokushika, Soji; Ganno, Shigetake; Sumizu, Koichiro; Hatano, Hiroyuki (Kyoto Univ.). J. Radiat. Res. (Jap.), 7: 47-57(June 1966).

From several experiments on oxidation radiolysis of cystine in air-containing aqueous solution a radiolytic mechanism is proposed. Final products are formaldehyde and carbon dioxide. Intermediate products are cystine–S–monosulfone, cystine hydrogen peroxide, cystine monosulfoxide, cystine disulfoxide, cysteine sulfinic acid, cysteic acid, sulfates, pyruvic acid, and ammonia. The chromatographic behavior of the intermediate products is described. (M.C.G.)

12455 RADIATION-INDUCED DECOLORATION OF DYESTUFFS IN AQUEOUS SOLUTION. Ogura, Hajime; Nagai, Toshihiko; Chu, Li-sen Edward; Kondo, Masaharu (Tokyo Metropolitan Univ.). J. Radiat. Res. (Jap.), 7: 58-66(June 1966).

The radioinduced decoloration of bromphenol blue, crystal violet and eosin Y in dilute aqueous solution was studied with and without the addition of second solutes. These second solutes are thiourea, benzoic acid, and its derivatives with gradually changing structure. The concentration of dyestuff was found to decrease exponentially with radiation dose, whether a second solute is present or not. This finding was explained in terms of the competition reaction of dyestuff and the second solute for free radicals produced in water. Of these compounds tested, thiourea, which is known as protector for enzyme deactivation, was found effective for dyestuff. From a kinetic treatment of the data, protection quotients of the second solutes were determined. It was shown that the protection quotient of benzoic acid or its derivatives with gradually changing structure is a linear function of substitution constant in Hammett's law, which cor-

relates the reactivity of substituted benzoic acid with their chemical structure. (auth)

12456 LUBRICANTS AND NUCLEAR RADIATION. Rodenbusch, Heinz (Mobil Oil AG, Geesthacht-Tesperhude, Ger.). Erdoel Kohle, 19: 583-7(Aug. 1966). (In German).

The effects of γ and neutron irradiation of lubricants are considered in relation to their use in nuclear reactors. Changes in the physical properties of lubricating oils and greases after exposure to 10^8 RAD of radiation in a nuclear reactor are discussed. From curves showing viscosity, penetration, oxidation stability, evaporation loss, and other properties, limits of stability against nuclear radiation were ascertained. On the basis of analyses of gaseous radiolysis products, conclusions are drawn about the mechanism of decomposition and the stability as a function of the chemical constitution of the lubricants. Details are given of the development of radiation-resistant lubricants and their application to the lubrication of nuclear power plants. A table shows the stability range of various types of greases and oils. (BBB)

12457 IDENTIFICATION OF A SPECIFIC MODE OF OXIDATION IN THE RADIOLYSIS OF THE PURINE BASES IN OXYGENATED AQUEOUS SOLUTION. Holian, John; Garrison, Warren M. (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Phys. Chem., 71: 462-3(Jan. 1967). (UCRL-17154).

Oxygen-saturated solutions of uric acid, xanthine, hypoxanthine, and adenine were irradiated with ^{60}Co γ rays at dosages in the range of 2.8 to 5.6×10^{18} eV/ml. The irradiated solutions, after treatment with HCl and 2,4-dinitrophenylhydrazine at 70°C for 1 hr, cooled, and extracted with chloroform, were transferred to filter paper and chromatographed with a butanol–ammonia solvent. Carbonyl yields from xanthine showed that OH radicals are quantitatively removed at the 5,6 double bond to give Galloxan = 2.0 G_{OH}; while those from hypoxanthine and uric acid indicated that although the 5,6 position of these compounds also represents the major locus of OH attack, other competing sites are involved. Adenine appeared essentially unreactive at the 5,6 position but evidence of chemical change was determined through chromatographic isolation on Dowex 50. (P.C.S.)

12458 YIELDS OF REDUCTION PRODUCTS OF THE RADIOLYSIS OF WATER IN NEUTRAL AND ALKALINE MEDIA. Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 169: 1119-22(1966). (In Russian).

Radiolytic conversions in a nitrate system at high dose rates (1 MeV electron radiation, doses of (3 to 6) $\times 10^{17}$ eV/ml) were investigated in a study of the yields of reduction products from the radiolysis of water at various pH. At pH 13, in contrast to neutral and weakly alkaline media, $G(NO_2^-)$ was found to be independent of the dose rate. The yield of nitrate at high dose rates could serve as a measure of the yield of hydrated electrons. In neutral solutions, $G(H_2O_2)$ increased at high dose rates, but still equaled only 1.35; in strongly alkaline medium, $G(H_2O_2)$ was practically the same at high dose rates as at low dose rates (equal to 0.4 at pH 13.2). The observed increase in the yield of hydrated electrons in alkaline medium may be due to several factors: interaction of hydrogen atoms (possible primary products of radiolysis) with OH^- ions in solution, yielding hydrated electrons; additional formation of e^-_{aq} in the reaction of hydroxyl ions with excited water molecules or radical pairs in the cell; possible generation of hydrated electrons and hydroxyl radicals on account of excitation and subsequent decomposition of hydroxyl ions; and partial suppression of the reaction of hydrated electrons and hydroxyl radicals as a result of the OH radical acceptor function of OH^- ions, leading to an increase in $G_{e^-_{aq}}$ and G_{OH}. (JPRS)

12459 γ RADIOLYSIS OF CYSTINE IN AQUEOUS SOLUTION. DOSE-RATE EFFECTS AND A PROPOSED MECHANISM. Purdie, John W. (Defense Research Board, Ottawa). J. Amer. Chem. Soc., 89: 226-30(Jan. 18, 1967). (DCBRL-508).

Solutions of L-cystine (CySSCy) in water (3×10^{-4} M) were exposed to 10,000 RADS of ^{60}Co γ rays. G values were determined for the following products: $CySO_2H$, $CySO_3H$, $CySO_2SH$, $CySSO_3H$, CySH, and CySSSCy. The effect of OH and e^-_{aq} scavengers on the yields was also investigated. The yields of $CySO_2H$, $CySO_3H$, and CySH were dose-rate dependent in the range 1 to 800 RADS/min. A mechanism for the radiolysis is presented and discussed: CySOH appears to be the main precursor of both $CySO_2H$ and $CySO_3H$ with O_2^- participating in formation of the latter. CySSSCy, the yield of which was independent of dose rate, is probably produced from cystine by reaction with CyS radicals. (auth)

12460 PULSE RADIOLYSIS STUDIES. IX. REACTIONS OF THE OZONIDE ION IN AQUEOUS SOLUTION. Felix, W. D.; Gall, Bonnie L.; Dorfman, Leon M. (Ohio State Univ., Columbus). J. Phys. Chem., 71: 384-92(Jan. 1967).

The radiation chemistry of strongly basic aqueous solutions containing oxygen and nitrous oxide was investigated by the pulse radiolysis method with particular attention to the decay kinetics of the ozonide ion. The apparent discrepancies in the literature concerning the kinetic order of the ozonide decay may be understood as an effect of pulse intensity and oxygen concentration. Absolute rate constants were determined for the following reactions at 25°C: $O_3^- + HO_2^-$ $(8.9 \pm 1.1) \times 10^5$ M^{-1} sec^{-1} pH 13.1 and 13.5, $e^-_{aq} + HO_2^-$ $(3.5 \pm 0.4) \times 10^9$ M^{-1} sec^{-1} pH 13.0, and $O^- + HO_2^-$ $(7 \pm 3) \times 10^8$ M^{-1} sec^{-1} pH 13.0, as determined by competitive kinetics based on a rate constant of 2.5×10^9 M^{-1} sec^{-1} for the reaction $O^- + O_2$. The rate constant for the reaction $O_3^- + O_3^-$ is substantially lower than previously reported and shows an inverse functional dependence on the oxygen concentration. At $[O_2] = 3.1 \times 10^{-3}$ M, the highest oxygen concentration attained, and pH 13.5 this rate constant has the value $2k = (0.9 \pm 0.2) \times 10^6$ M^{-1} sec^{-1} where it seems to be leveling off. This value is based on our determination of $\epsilon_{O_3^-}^{4300} = 1900 \pm 120$ M^{-1} cm^{-1} for the molar extinction coefficient of the ozonide ion at 4300 A. (auth)

12461 IRRADIATION OF ESTRONE IN AQUEOUS SOLUTIONS. Wheeler, O. H.; Montalvo, R. (Puerto Rico Nuclear Center, Mayaguez). Int. J. Appl. Radiat. Isotop., 18: 127-31(1967).

The radiolysis of estrone in 1N sodium hydroxide gave predominantly 2-hydroxyestrone, with a $G_{(-M)}$ of 1.14 (G-value for reaction of starting material). Estradiol similarly afforded 2-hydroxyestradiol ($G_{(-M)}$ of 1.54). In 80% acetic acid estrone and estrone acetate gave small amounts of 2- and 4-hydroxylated compounds, while estrone formed a small amount of 2-hydroxyestrone in 90% acetic acid. (auth)

12462 EXCHANGE REACTIONS OF T WITH HD AT HIGH KINETIC ENERGIES. Seewald, David; Wolfgang, Richard (Yale Univ., New Haven). J. Chem. Phys., 46: 1207-8(Feb. 1, 1967).

Measurements are reported on the hot-atom reactions, T + HD → HT + D or T + HD, over the full energy range. This system is free of the complication of having two different center-of-mass systems, which can give rise to effects that obscure factors of a more chemical nature. The isotope effect found shows a drastic reversal over that with the homonuclear hydrogen molecules. Measurements were made on the total probability that the tritium, starting at an essentially infinite energy in chemical terms, would form HT or DT before thermalization. These probabilities, P_{HT} and P_{DT}, were determined as a function of dilution of the HD by argon moderator. At all levels of moderation, production of DT was favored over HT by about 50%. (W.D.M.)

12463 ON THE IMPORTANCE OF THERMAL PEAKS IN THE RADIATION-INDUCED DECOMPOSITION OF SALTS, INDUCED BY HEAVY CHARGED PARTICLES. Oblivantsev, A. N.; Boldyrev, V. V.; Eremin, L. P.; Lykhin, V. M. (Tomsk Polytechnic Inst., USSR. Inst. of Chemical Kinetics and Combustion, Academy of Sciences, Siberian SSR). Kinet. Kataliz, 7: 1015-19 (Nov.-Dec. 1966). (In Russian).

Data are presented on the radiochemical stability of alkali metal azides and perchlorates irradiated with 4.7-MeV protons, and on the isothermal annealing of potassium nitrate with lead and strontium impurities, irradiated with the 4.7-MeV protons. A possible relation between the mechanism of radiolysis of the salts and thermal effects in the charged particle tracks was analyzed. The hypothesis on the importance of the thermal effects in ionizing particle tracks during chemical transformations in solids irradiated by heavy charged particles was not confirmed. (tr-auth)

12464 RADIATION-CHEMICAL INVESTIGATION OF LIQUID POLYORGANOSILOXANES WITH A VARIOUS CONTENT OF AROMATICS IN THE MAIN AND SIDE CHAINS. Ponomareva, T. I.; Krasovskaya, T. A.; Sobolevskii, M. V.; Ponomarev, A. N. Kinet. Kataliz, 7: 983-9(Nov.-Dec. 1966). (In Russian).

The radiolysis of liquid polyorganosiloxanes (polydimethylsiloxanes, polydimethylphenylenesiloxanes, and polydimethylphenylsiloxanes) at dose rates from 0.25 to 1.25 MRAD/sec and radiation doses up to 100 MRAD was studied. Radiation yields of hydrogen, methane, and ethane formed by radiolysis were measured, and the dependence of viscosity on radiation doses was estimated. It was revealed that the radiation stability of polyorganosiloxanes increased with increases in the number of aromatic groups in a molecule. A basic scheme of chemical formation of gaseous products is suggested. (tr-auth)

12465 RADIOLYSIS OF WATER ADSORBED ON SILICAGEL. Krylova, Z. L.; Dolin, P. I. (Inst. of Electrochemistry, Academy of Sciences, USSR). Kinet. Kataliz, 7: 977-82(Nov.-Dec. 1966). (In Russian).

A high radiation yield of H_2 and CO_2 (40 and 15 molecules, respectively, per 100 eV calculated for water absorbed energy) was observed during the gamma radiolysis of water adsorbed on silica gel (heated at 280 to 420°C with continous pumping for 10 hrs). The considerable yield of H_2 was the result of the transfer of additional

energy from the solid to adsorbed water. The formation of CO_2 was the result of the oxidation of organic materials on the surface of the silica gel. Purification of the surface resulted in reduced radiolytic yield. The presence of adsorbed water on irradiated silica gel resulted in changes in the EPR spectra at –196°C and in the disappearance of the spectra at room temperature. This phenomenon confirms the transfer of energy from silica gel to water. (tr-auth)

12466 RADIATION-INDUCED OXIDATION OF METHANOL. Ladygin, B. Ya.; Saraeva, V. V. Kinet. Kataliz, 7: 967-76(Nov.-Dec. 1966). (In Russian).

Studies of the gamma-induced oxidation of liquid methanol showed that at low temperatures the yields did not depend on the temperature or the dose. At temperatures above 0°C the yield increased sharply with an increase in temperature. Reduced dosage resulted in increased yields of H_2O_2 and CH_2O. The yield of radicals initiating the oxidation process at various temperatures was calculated. The energy of activation of the chain initiating reaction, the ratio of the growth constant to chain breakage, and the balance of oxidation products at low temperatures were determined. (tr-auth)

12467 ION LOSS BY DIFFUSION IN THE RADIOLYSIS OF GASES. Klots, Cornelius E.; Anderson, Verner E. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 71: 265-7(Jan. 1967).

The role of surface neutralization in gases homogeneously irradiated in spherical vessels was studied mathematically. It was found that diffusion was ambipolar in typical situations. Comparison with experiments suggested that uncontrolled effects, probably thermal convection currents, apparently enhance the role of surface neutralization beyond that calculated. (auth)

12468 PARAMAGNETIC RESONANCE OF METAL IONS AND DEFECT CENTERS IN TOPAZ. Dickinson, Alan C.; Moore, Walter J. (Indiana Univ., Bloomington). J. Phys. Chem., 71: 231-40(Jan. 1967).

EPR of Fe^{3+} impurities in colorless topaz was measured at 77 and 300°K with X-band frequencies. The most intense peaks occurred at g values > 2 and were split by hyperfine interaction with two fluoride ions. It was determined that Fe^{3+} substitutes for Al^{3+} in nearly octahedral sites. The principal axis of the paramagnetism was close to a threefold axis of the octahedron. Second- and fourth-order axial and second-order rhombic components dominated the spin Hamiltonian with values: D = –9.699, E = 2.503, and F = 0.800 Gc/sec. The EPR spectrum of yellow topaz showed an octet of peaks near g = 2 due to V^{4+} and several broad peaks at lower fields due to Cr^{3+}. On heating to 500°K, yellow topaz became pink and blue topaz became colorless, in both cases with the loss of EPR peaks near g = 2. Irradiation of all samples produced an amber-yellow color and gave rise to several peaks near g = 2. These heat and irradiation-sensitive peaks were assigned to various types of electronic defect centers. (auth)

12469 HIGH-ENERGY INDUCED ISOMERIZATION OF STILBENE IN BENZENE SOLUTION. Hentz, Robert R.; Shima, K.; Burton, Milton (Univ. of Notre Dame, Ind.). J. Phys. Chem., 71: 461-2(Jan. 1967).

The mechanism involved in ^{60}Co γ-induced isomerization of stilbene in benzene solutions was studied with emphasis on the role of ionizable impurities, concentration of dose, and time of irradiation. High-purity cis-stilbene irradiated at 2.98×10^{18} eV ml^{-1} for 2.5 min gave G(c → t) that ranged up to 210 in contrast to earlier data that showed no effects from purification nor time of irradiation. Results suggest a chain mechanism is involved. Using this G ~ 210, calculations lead to an ionic chain length of about 2000. (P.C.S.)

12470 STATISTICAL ASPECTS OF AUTOIONIZATION LIFETIMES. Klots, Cornelius E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 1197-9(Feb. 1, 1967). (ORNL-P-2563).

Long-lived, parent-molecule negative ions can serve as convenient prototypes for the autoionizing species frequently postulated in radiation chemistry. Recent measurements of the rates of formation and autoionization of a number of such ions are discussed. The assumptions involved in the derivation of electron affinities from the measurements are found to be identical with those inherent in unimolecular decomposition theory. Implications for photo- and radiation chemistry are noted. (auth)

12471 ELECTRON SPIN RESONANCE OF γ-IRRADIATED CRYSTALS OF BROMOACETIC ACID. Suttle, J. R.; Lontz, R. J. (Army Research Office, Durham, N. C.). J. Chem. Phys., 46: 1539-41(Feb. 15, 1967).

A partial electron spin resonance analysis of ^{60}Co γ-irradiated single crystals of bromoacetic acid is reported which indicates stable free radicals with unpaired spin density in a bromine orbital. (W.D.M.)

12472 ELECTRON SPIN RESONANCE SPECTRA OF X-IRRADIATED SINGLE CRYSTALS OF 3,3'-DITHIODIPROPIONIC ACID: "B $\cos^2\theta$" RULE FOR SULFUR RADICALS. Kurita, Yukio (Toyo Rayon Co., Ltd., Kamakura, Japan). Bull. Chem. Soc. Jap., 40: 94-6(Jan. 1967).

The electron spin resonance of x-irradiated single crystals of 3,3'-dithiodipropionic acid was measured at room temperature. From the analysis of the anisotropy in the spectra, the free radical produced was confirmed to be of the $HO_2C \cdot CH_2 \cdot CH_2 \cdot S$ form. The principal values of the g factor were 2.003, 2.025, and 2.055, while the isotropic coupling constants for the two β protons were 12.4 G and 5.3 G. In this free radical the unpaired electron was mainly concentrated in a 3pπ orbital of the sulfur atom. For the isotropic coupling constant of the β proton in this type of radical, the "B $\cos^2\theta$" rule is applied successfully using the value of 12.8 G for B. (auth)

12473 IONIC INTERMEDIATES IN γ-IRRADIATED ORGANIC GLASSES. STILBENE ANIONS IN 2-METHYLTETRAHYDROFURAN. Torikai, Ayako; Fueki, Kenji; Kuri, Zen'ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap., 40: 223-4(Jan. 1967).

The ionic intermediates of trans- and cis-stilbene produced by the gamma irradiation of 2-methyltetrahydrofuran (MTHF) glasses at 77°K were investigated by both spectrophotometric and electron spin resonance measurements. The absorption spectrum of gamma-irradiated trans-stilbene solution was attributed to the anion radical of trans-stilbene, since the positions of the absorption maxima were essentially the same as those of the chemically-prepared trans-stilbene anion radical. The spectrum obtained from the gamma-irradiated cis-stilbene solution was attributed to the anion radical of cis-stilbene since the spectrum was different from that of the anion radical of trans-stilbene. The optical density of the 700 mμ band for both trans- and cis-stilbene was linear with dose to about 8×10^4 RAD. When cis-stilbene in MTHF solutions was irradiated at a dose of 10^5 RAD at 77°K then warmed to room temperature, the isomerization of cis-stilbene to trans-stilbene was not observed. (D.H.M.)

12474 AN ESR STUDY OF IRRADIATED CYCLIC HYDROCARBONS IN SOLID STATE. Ohmae, Tadayuki (Osaka Univ.); Ohnishi, Shun-ichi; Kuwata, Keiji; Sakurai, Hiroshi; Nitta, Isamu. Bull. Chem. Soc. Jap., 40: 226-8(Jan. 1967).

The cycloalkanes (C_5H_8 to C_8H_{16}) and cycloalkenes (C_5H_8 to C_8H_{14}) were irradiated at –196°C with an electron beam from a Van de Graaff accelerator. Electron spin resonance measurements were made at various temperatures from –196°C to near the melting point of the samples. Interest was focused on the structures of radicals trapped in the matrices of parent molecules. (D.H.M.)

12475 SHF PLASMATRON AND SOME POSSIBLE AREAS OF ITS APPLICATION IN CHEMISTRY. Aksenov, V. P.; Blinov, L. M.; Marin, V. P.; Polak, L. S.; Shchipachev, V. S. Kinet. Termodinam. Khim. Reaktsii Nezkotemp. Plazme, Akad. Nauk SSSR, Inst. Neftekhim. Sinteza, 233-7(1965). (In Russian).

Using the ionizing effect of SHF radiation the following processes can be carried out: synthesis of ammonia, recovery of nitrogen oxides from air (in the production of nitric acid); synthesis of hydrochloric acid and hydrocyanic acid; recovery of sulfur from hydrogen sulfide and flue gases; petroleum cracking; preparation of acetylene from methane; production of alcohols; chlorination, nitration, hydroxylation, and carboxylation reactions; synthesis of benzene, biphenyl, and phenol; polymerization of ethylene; preparation of pyroceramics; and preparation of ultrapure films and metals. A diagram of the pulsed SHF device is given, and certain characteristics of the SHF discharge are described. Results of measurements of the temperatures and concentrations of electrons and ions in the SHF discharge and of preliminary experiments on the formation of nitrogen oxides in the SHF plasmatron are given. (JPRS)

12476 RADIATION-INDUCED CATALYTIC CONVERSIONS: ORGANIC COMPOUNDS ADSORBED ON SOLIDS OF DIFFERENT ELECTRONIC PROPERTIES. Zhabrova, G. M.; Vladimirova, V. I.; Kadenatsi, B. M.; Kazanskii, V. B.; Pariiskii, G. B. (Inst. of Chemical Physics, Moscow). J. Catalysis, 6: 411-18(Dec. 1966).

The low-temperature radioinduced conversions of methanol and cyclohexane adsorbed on solids were investigated. The solids used were dielectrics (SiO_2, silica-alumina, Al_2O_3, KF), semiconductors (ZnO, NiO), and metals (Pt, Pd). The samples were irradiated by ^{60}Co γ rays at a dose rate of 4.5×10^{16} eV/g sec. Adsorption, kinetic, and ESR methods were used. The highest activity was displayed by solids with a broad forbidden band, such as SiO_2, Al_2O_3, silica-alumina, and KF. The maximum radioinduced catalytic conversion was observed at a low coverage of silica gel. Radioinduced defects and surface-adsorbed radicals, namely $\cdot C_6H_7$ for cyclohexane and $\cdot CH_2OH$ for methanol were detected on insulators by the

ESR technique. For semiconductors the radiation yield was considerably lower. Metals had no effect on the reaction rates. Correlation between the radioinduced activity of solids and the intensities of ESR signals due to adsorbed radicals was established. The amount of methanol decomposition products and of the radicals formed was studied as a function of the dose rate. The possible mechanism of radioinduced conversions in the adsorbed layer, involving electron and radical steps, is discussed. (BBB)

12477 RADIATION-CHEMICAL OXIDATION OF BUTANOL. EFFECT OF BUTANOL CONCENTRATION ON THE COMPOSITION AND YIELD OF PRODUCTS. Komarov, P. N. Petrol. Chem. (USSR) (Engl. Transl.), 5: No. 4, 303-9(1966).

A comparative study was made of the ^{60}Co radioinduced oxidation of pure butanol and butanol in aqueous solution (concentration 0.98 mole/l) at a temperature of 150°C. Variation of the ratio between the reaction products, observed on changing from oxidation of the absolute alcohol to its radioinduced conversion in an aqueous solution (0.98 mole/l), was due to the reduction of alcohol concentration. In the radioinduced oxidation of absolute butanol, ^{60}Co γ radiation, in addition to stimulating the initial stage of the process, stimulated the oxidation of n-butyraldehyde, formed during the reaction, to n-butyric acid. A reaction mechanism showing a step-by-step sequence is proposed. This scheme is based on the amounts of ethylene glycol, acetaldehyde, and acetic acid in the reaction products. The conversion, according to reactions proposed, accounts for the formation of identical amounts of ethylene glycol and acetaldehyde, on the one hand, and of acetic acid, on the other. The observed increase in the proportion of ethylene glycol, acetaldehyde, and acetic acid in the reaction products in oxidation in aqueous solution is considered proof of the preferential formation of the radical $CH_3CHCH_2CH_2OH$ in the aqueous phase. All the products observed are also seen in appreciable quantities in pure alcohol during thermal oxidation. This points to the fact that in liquid-phase oxidation of butanol the reaction chain is formed by 2 independent pathways, which are not related to the means of formation of initial active centers. An increased content of these products on oxidation in solution can be explained by the reduction in alcohol concentration. (BBB)

12478 ALPHA- AND BETA-RADIOLYSIS OF AQUEOUS SOLUTIONS OF LIGHT AND HEAVY WATER. Vladimirova, M. V.; Kulikov, I. A.; Shulyatikova, L. G. Radiokhimiya, 8: 226-32 (1966). (In Russian).

The effect of various substances on the yield of hydrogen formed under the influence of α radiation (emitted by dissolved polonium) and β radiation (emitted by dissolved tritium) in ordinary and heavy water (D_2O) containing 3×10^{-3} M Fe^{2+} was studied. The criterion of capture of H and D radicals was the value of the initial hydrogen yield. The yields of radical products of radiolysis, obtained from the dependence of the oxidation of iron on the absorbed energy, showed the presence of a considerable isotope effect. The influence of the hydrogen radical acceptors NO_3^-, NO_2^-, and UO_2^{2+} on hydrogen and deuterium yields in the α and β radiolysis of light water and α radiolysis of heavy water was determined. It was found that the decrease of H_2 yield is different in these two media. This is due to the difference in the radii of the Gaussian distribution of the H and D radicals, and also to the difference in the rate constants of the reactions between the radicals and the acceptors. (JPRS)

12479 EFFECT OF γ-RAY IRRADIATION ON SOAPS. Saito, Ken (Mitsuma Soap Co., Ltd., Japan); Noguchi, Shun. Yukagaku, 15: 537-41(Oct. 1966). (In Japanese).

The effects of γ (^{60}Co) irradiation on the crystal form or crystallinity of soaps was studied by x-ray diffraction methods. With irradiation up to 2×10^7 R total dose, all soaps, either commercial or single fatty acid, were very resistant to radiation. Only a slight increase in crystallinity was noted for commercial soaps. The solubility of the soaps by abrasion was measured also. (NSA of Japan)

12480 FURNACE FOR THE PRODUCTION OF RADIOACTIVE IODINE. Bardy, Andre; Le Francois, Jacques; Murthy, Tantrauahi Suryanarayana (to Commissariat a l'Energie Atomique). British Patent 1,050,690. Dec. 7, 1966. Priority Date Oct. 2, 1964 and July 20, 1965, France.

A furnace is described for the production of ^{131}I by heating irradiated Te and removal of the vaporized ^{131}I by a neutral gas, such as argon. The furnace comprises a tubular muffle including the heating means, an inlet passage for the neutral gas at one end of the muffle, and gas discharge passage with heating means at the other end of the muffle. An orifice for loading the muffle is provided and is closed by a plug that can be moved parallel to the muffle axis and that can be pivoted transversely to clean the muffle orifice. The means for shifting and pivoting the plug can be remote means, such as two pneumatic jacks controlled from outside the hermetically sealed enclosure in which the furnace is placed. The tubular muffle is made of or lined with a non-iodine-absorbent material, such as alumina. (B.L.M.)

12481 NOVEL METHOD FOR POLYMERIZATION OF FORMALDEHYDE. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1966-1431. Feb. 3, 1966. Filed Feb. 13, 1963.

Formaldehyde can be polymerized with a high G-value by irradiation with an ionizing radiation in the presence of acid anhydrides at a temperature above −20°C, to give high polymers of formaldehyde with excellent plastic properties, not inferior to polyformaldehyde resins obtainable by the conventional methods. (NSA of Japan)

12482 METHOD FOR PRODUCING STEREOSPECIFIC POLYACRYLONITRILE BY IONIZING RADIATION. Sobue, Hiroshi. Japanese Patent 1966-1552. Feb. 4, 1966. Filed May 1, 1963.

A method is proposed for producing isotactic polyacrylonitrile of stereospecific structure by low-temperature solid-state irradiation polymerization of acrylonitrile monomers admixed with one or any combination of the following compounds: nitrile compounds, acetone derivatives, alcohols, benzene derivatives, or metal oxides. Ionizing radiation is used for the irradiation. (NSA of Japan)

12483 MICRO-POROUS POLYETHYLENE AND A PROCESS FOR THE MANUFACTURE THEREOF. (to W. R. Grace and Co.). British Patent 1,051,320. Dec. 14, 1966. Priority date Jan. 13, 1964, United States.

Shaped articles of microporous crosslinked polyethylene are formed by mixing normally solid polyethylene and 20 to 400 wt % of a pore-forming solid with a particle diameter of 0.1 to 10 μ, shaping the mixture into the desired shape at a temperature at least sufficient to melt the polyethylene, crosslinking the polyethylene by irradiation with ionizing radiation, and then removing the pore-forming solid at a temperature below the degradation temperature of the crosslinked polyethylene. Crosslinking may be accomplished by adding 0.1 to 10 wt % of an organic compound capable of generating free radicals or by irradiation with ionizing radiation. (B.L.M.)

12484 METHOD FOR PRODUCING THERMALLY-STABLE POLYMERS OF FORMALDEHYDE. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1966-235. Jan. 11, 1966. Filed Aug. 26, 1963.

A method is proposed for producing thermally-stable high polymers of formaldehyde with sufficient mechanical strength for use as plastic materials by irradiating mixtures of formaldehydes and ketenes with an ionizing radiation at temperatures above −50°C with carbon dioxide or an organic carboxylic acid anhydride added as a third component. Addition of inorganic or organic acid anhydrides such as CO_2, maleic anhydride, succinic anhydride, or itaconic anhydride to the mixture had the effect of suppressing the undesirable chain terminating reaction and resulted in the elimination of polymer molecules of undesirable low molecular weight even at a relatively high temperature near the ambient temperature. (NSA-Japan)

12485 METHOD FOR PRODUCING POLYVINYL CHLORIDE RESIN COMPOSITIONS. Suzuki, Fumio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1966-1423. Feb. 3, 1966. Filed Mar. 11, 1963.

Resin compositions of high thermal stability and solvent resistance can be obtained by the irradiation of polyvinyl chloride resins containing long-chained ester compounds, such as polyesters, as the compounded ingredients. Other properties resultant from the process, including mechanical properties (tensile strength, elongation, hardness, etc.), electric properties, and appearances cause no inconvenience in actual use of the resins. (NSA of Japan)

12486 PROCESS FOR CROSS LINKING POLYMERS. (to Toyo Rayon Kabushiki Kaisha). British Patent 1,054,137. Jan. 4, 1967. Priority date Apr. 9, 1963, Japan.

A method is described for cross linking polymers of high molecular weight by subjecting them to irradiation by ionizing radiation and contacting them with acetylene before, during, or after the irradiation. The process is applicable to the following polymers: synthetic polyamide compounds, synthetic polyolefin compounds, synthetic polyvinyl compounds, and natural or synthetic polymers whose polymeric component is predominantly a diolefin having a conjugated double bond. (B.L.M.)

12487 METHOD FOR THE PRODUCTION OF CHLORINE-CONTAINING CYCLIC ETHERS. Matsuda, Tatsuo (to Agency of Industrial Science and Technology, Tokyo). Japanese Patent 1966-4708. Mar. 15, 1966. Filed May 20, 1963.

A method is proposed for the production of chlorine-containing

cyclic ethers, namely, saturated chlorine-containing cyclic ethers, which are the 1:1 addition compounds of tetrachloroethylene and cyclic ethers, and the unsaturated chlorine-containing cylic ethers, which have the dehydrochlorinated structure of the corresponding saturated ones, by the utilization of an ionizing radiation including x rays or of a catalyst initiating the free-radical reactions. For example, when tetrahydrofuran is used as the cyclic ether, the products are 2-(1,1,2,2-tetrachloroethyl)tetrahydrofuran and 2-(1,2,2-trichlorovinyl)tetrahydrofuran, and when the cyclic ether is paradioxane, 2-(1,1,2,2-tetrachloroethyl)paradioxane and 2-(1,2,2-trichlorovinyl)paradioxane are obtained. It is possible to select the free-radical generating sources and the reaction conditions in order to obtain either the saturated or the unsaturated chlorine-containing cyclic ethers as the main product. (NSA of Japan)

Radiochemistry

Refer also to abstracts 12373, 12380, and 12417.

12488 (CNEA-177) CALIBRACION DE MEZCLAS DE ^{95}Zr-^{95}Nb POR ESPECTROMETRIA GAMMA. (Calibration of ^{97}Zr-^{95}Nb Mixtures by Gamma Spectrometry). Tenreyro, Elma A. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1966. 14p. (In Spanish). Dep. mn.

A routine method for the calibration of ^{95}Zr-^{95}Nb by gamma spectrometry is proposed. The absolute activities are obtained using conversion factors of counting rate into disintegration rate. The method of determination of such factors for these nuclides is given. The knowledge of the time when ^{95}Zr was free of ^{95}Nb is necessary. One complete analysis takes less than one hour. (auth)

12489 PREPARATION OF LIQUID STANDARDS OF ^{227}Ac. Gorshkov, G. V.; Volkova, E. A.; Ziv, D. M.; Shestakova, I. A.; Shimanskaya, N. S. Radiokhimiya, 8: 223-6(1966). (In Russian).

Liquid standards of Ac containing 10^{-10} to 10^{-5} Ci were prepared. Other radiation sources such as Ra, Th, and ^{228}Th are not contained in this standard. The precision of the preparation of Ac standards with activities of 10^{-7} to 10^{-5} Ci is ±2% and with activities of 10^{-10} to 10^{-8} Ci ±3%. The standards can be used immediately as comparison standards during emanation measurements of Ac as well as for the verification of Ac standards prepared from U minerals. (tr-auth)

12490 REACTIONS OF TRITIUM RECOIL ATOMS WITH AMINO ACIDS. Simonov, E. F.; Nesmeyanov, An. N. (Inst. of Theoretical and Experimental Physics, Moscow). Vestn. Moskov. Univ., Ser. II: Khim., No. 3, 71-4(May-June 1966). (In Russian).

Reactions of hot tritium atoms with the glycine-norleucine amino acids were studied to determine the mechanism of tritium recoil with organic compounds. Results indicated that the initial interactions of the tritium recoil atoms with amino acids are determined by spatial factors (direction, collision place, and steric hindrance) and by further formation of an intermediate complex capable of extra energy dispersion at the expense of the reconstruction or disintegration. (R.V.J.)

12491 REACTIONS OF 40-keV TRITIATED IONS WITH SOLID ORGANIC COMPOUNDS. Ascoli, Sergio; Cacace, Fulvio; Giacomello, Giordano; Possagno, Elvira (CNR, Rome. Univ., Rome). J. Phys. Chem., 71: 427-30(Jan. 1967).

Labeled products formed from the reactions of 40-keV tritiated ions with solid organic targets, such as sodium m-iodobenzoate, sodium phenylacetate, and sodium benzoate, were determined. The radiochemical yield and the intramolecular tritium distribution corresponded within analytical errors to the values obtained in experiments involving the use of the much more energetic recoil tritons, as expected on the basis of the current theories on the "hot" chemistry of tritium. In addition, it was demonstrated that mono- and polyatomic tritiated ions react with a given target to give the same products, a result consistent with the view that high-energy polyatomic species dissociate into the constituent atoms in their initial collisions with the target molecules, before their energy is sufficiently lowered to make the formation of stable products possible. (auth)

12492 IMPROVEMENTS RELATING TO APPARATUS FOR CARRYING OUT A BATCH-SEQUENTIAL PROCESS ON LIQUIDS. Baker, Leslie Charles; Vonberg, Derek Daniel (to National Research Development Corp.). British Patent 1,053,736. Jan. 4, 1967. Filed Oct. 5, 1962.

An apparatus is described for remote control of batch-sequential processes on liquids, e.g., manipulation of radioactive chemicals. The apparatus includes upper and lower members rotatable independently about a common axis. Each member is adapted to support at different orientations about its periphery different items required in the batch-sequential process. Operating and locking means are provided for independent operation and locking of the two members. The locking means is such that each member can be locked at each of a number of predetermined orientations in which an item supported by the upper member is properly positioned relative to an item supported by the lower member so that liquid transfer means can be utilized as one of the items supported by the upper member and a liquid container utilized as one of the items supported by the lower member. The liquid transfer means, such as a pipette, can then be used as necessary in the process for the insertion and/or withdrawal of liquid relative to the container. (B.L.M.)

Separation Processes

Refer also to abstracts 12297 and 12317.

12493 (BNL-9821) INVESTIGATIONS AND APPLICATIONS OF THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. I. TELLURIUM ISOMER GENERATORS. Hillman, Manny; Weiss, Allen J. (Brookhaven National Lab., Upton, N. Y.). Jan. 3, 1966. Contract AT-30-2-GEN-16. 13p. (CONF-660503-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 7th Japanese Conference on Radioisotopes, Tokyo.

Alumina was used to prepare an isomer generator as follows: ^{129m}Te(VI) was adsorbed on alumina at a particular pH, and the alumina was left at that pH while the ^{129g}Te grew in. That part of ^{129g}Te that grew in as Te(IV) was eluted with 3 N NaOH, and the generator was converted back to the original pH for further growth of ^{129g}Te. The milking yield in 3 N NaOH was 22.4 ± 0.6. Isomer generators were also prepared using Dowex-50Wx8. The ^{129m}Te(VI) was adsorbed on the resin from 1 N NaOH, and ^{129g}Te(IV) was eluted, also with 1 N NaOH. The milking yield was 20 to 22%. (P.C.H.)

12494 (BNWL-CC-372) MELT ATMOSPHERE CONTROL STUDIES FOR THE SALT CYCLE PROCESS. Bloom, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 26, 1966. Contract AT(45-1)-1830. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Salt Cycle process has been developed to process short cooled UO_2-PuO_2 based fuels for recycle to thermal heterogeneous reactors. Efficient and well-controlled operation of the Salt Cycle process demands that the atmosphere over the salt melt contain a minimum amount of air and moisture. Modifications and tests made on the salt pot atmosphere control lid in order to decrease the amount of undesirably moist air leaking through the salt pot lid into the melt atmosphere are described. The proposed system successfully prevented air leakage into the salt melt atmosphere open operated with 0.005 in. H_2O vacuum. (P.C.H.)

12495 (BNWL-CC-373) DETECTION AND OXIDATION RATE STUDIES OF U(IV) IN THE SALT CYCLE PROCESS. Bloom, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 26, 1966. Contract AT(45-1)-1830. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A U(IV) concentration meter was tested in the low radiation level Salt Cycle mock-up facility, and U(IV) oxidation rates were determined and used to predict plutonium oxidation rates. The U(IV) concentration meter was able to detect concentrations as low as 0.18 wt % U(IV) and gave a qualitative indication of changes in U(IV) concentration. The oxidation rates, which were determined as a function of vol % O_2 in a 4 l/min O_2-Cl_2 sparge, were found to increase linearly with increased vol % O_2 up to 85 vol % O_2. Above 85 vol % O_2 in the sparge gas the oxidation rate increased rapidly with increased vol % O_2 to a maximum oxidation rate of 0.41 wt % U(IV)/hr at 100 vol % O_2. Predicted plutonium oxidation rates are given. (P.C.H.)

12496 (EURAEC-1703) THE REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 24, January 1-March 31, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 43p. (EUR-2890). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Three reaction sequences were studied with a view to processing fuels in mixed dioxide form: oxidation, hydrofluorination, fluorination with chlorine trifluoride and then with fluorine; the same sequence without hydrofluorination; and direct attack on the compact fuel with chlorine trifluoride followed by fluorine treatment. The first two, especially the second, revealed the subtilization of the greater part of the uranium out of a considerable mass of plutonium. Direct attack on the mixed oxide necessitates a relatively high reaction temperature which seems to be at the origin of a simultaneous plutonium subtilization. Re-

search is in hand towards carrying out the simultaneous oxidation and hydrofluorination of uranium dioxide in a fluid bed (first sequence above). The scale of work will shortly be upgraded from 0.5 to 4 kg. Various chlorine trifluoride reaction tests showed the possibility of processing carbides as well as uranium mixed with powders from the decladding of stainless steel. Studies were also made on absorption of chlorine (chlorine trifluoride reaction product) by solid soda lime, with a view to reducing the volume of active waste. Very high capacities have been obtained; chlorine absorption is quantitative. (auth)

12497 (IN–1018) A STUDY OF THREE METHODS FOR REPROCESSING GRAPHITE FUELS: MIXED ACID OXIDATION, GRIND-LEACH, AND ELECTROLYTIC DISINTEGRATION. Decker, L. A.; Hammer, R. R. (Idaho Nuclear Corp., Idaho Falls). Jan. 1967. Contract AT(10-1)-1230. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two processes, mixed nitric acid–sulfuric acid oxidation and grind-leach, were found to be chemically feasible for reprocessing nuclear rocket fuels; with further work, these processes should be suitable also for reprocessing other graphite fuels such as those using uranium carbide particles coated with refractory materials. A third process, electrolytic disintegration, was found to be unsatisfactory. (auth)

12498 (JAERI–1115) ISOTOPE SEPARATION BY LIQUID-GAS CHEMICAL EXCHANGE. Ishida, K.; Mishima, M.; Matsuda, Y.; Komori, T.; Tamura, S. (Japan Atomic Energy Research Inst., Tokyo). June 1966. 14p. (In Japanese). Dep. mn.

The isotope separation process in a packed column in which two or more different chemical substances are brought into contact in the countercurrent flow was analyzed with the liquid–gas chemical exchange $H^{12}CO_3^-(l) + {}^{13}CO_2(g) \rightleftharpoons H^{13}CO_3^-(l) + {}^{12}CO_2(g)$ as an example; the solution for the unsteady state in particular is discussed in detail. The effects on the enrichment of the column length, geometry and physicochemical properties of the packing material, liquid flowrate, isotopic exchange rate, temperature, and separation factor were studied by comparison of theoretical and experimental results. (auth)

12499 (LA–3499) ANION-EXCHANGE PROCESSING OF PLUTONIUM. James, Dean B. (Los Alamos Scientific Lab., N. Mex.). Jan. 4, 1966. Contract W-7405-eng-36. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review is presented of the nitrate solution, anion-exchange technique for the purification and concentration of plutonium, emphasizing the chemical and chemical engineering nature of the process. The fundamentals of ion exchange and the solution chemistry of plutonium are reviewed. The basic chemistry of the nitrate, anion exchange of plutonium is described along with the applied process. (auth)

12500 (RISO–133) SELECTIVE FLOTATION OF STEENSTRUPINE AND MONAZITE FROM KVANEFJELD LUJAVRITE. Soerensen, Emil; Lundgaard, Th. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1966. 17p. Dep. mn.

As part of the work for exploitation of the uraniferous rock in southern Greenland a flotation process was developed. The uranium- and thorium-bearing minerals, mainly lanthanide phosphosilicates, can be flotated selectively with oleic acid as collector and sodium silicate as a regulating agent. Experiments indicate that linoleic acid is a more efficient collector than oleic acid. A characteristic feature is the sensitivity to cations in the process water, which excludes the use of tap water for the experiments. This led to the utilization of lanthanum as an activator. (auth)

12501 (USNRDL-TR–1091) ION EXCHANGE IN FUSED SALTS. III. THE CATION EXCHANGE CHARACTERISTICS OF SOME BORATE, BOROSILICATE, AND BOROPHOSPHATE GLASSES IN FUSED SODIUM NITRATE. Rowell, Monte H. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 13, 1966. Contract AT(49-2)-1167. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Six glasses, comprised of two alkali borates, two salt-loaded alkali borates, one low-silica borosilicate, and one borophosphate, were prepared and tested as ion exchangers for use with fused-salt solvents. The high-alkali borate glasses showed excellent selectivity among Cs, Na, Sr, Ba, and Eu in molten $NaNO_3$, and appeared to be more generally effective as ion exchangers in fused salts than any material previously tested. Inclusion of NaCl to the limit of its solubility in alkali borate glass greatly improved the rate of ion diffusion in the glass, thus removing the major drawback of glasses as ion exchangers. Inclusion of Na_2SO_4 did not have the same beneficial effect as that of NaCl. The borosilicate and borophosphate glasses tested did not show as good ion-exchange characteristics as did the pure alkali borates. High-alkali borate glasses showed selectivity for cations in the order of increasing field strength of the cation. The selectivity behavior provided information about the nature of the ion-exchange process in fused salts. (auth)

12502 (AEC-tr–6844) CHARACTERIZATION AND PHYSICAL CONCENTRATION OF SPANISH URANIFEROUS QUARTZITES. de Lora, F. Translated from paper Presented at the Panel Discussion on the Treatment of Uranium Ores at Low Concentration, International Atomic Energy Agency, Vienna, June 27–July 1, 1966. 21p. Dep. mn. JCL $2.60 fs, $0.86 mf.

A sample of radioactive material originating from Santa Elena (Jaen) was investigated; the material contains 130 ppM of U_3O_8, 600 ppM of ThO_2, 4.96% of ZrO_2, and 14.29% of TiO_2. The volume of the deposit is more than 150,000,000 tons. This material may be defined as a rutile- and zircon-bearing quartzite, with its radioactivity due to two sources: the uranium incorporated in the zircon lattice, and the presence of monazite. The possibility of the presence of brannerite and davidite is ruled out. Nor is there any conclusive evidence that the material contains sphene; rutile is the most abundant titanium material present in the ore. The characteristics of the ore were determined, with a view to its physical concentration. Separation tests were carried out using magnetic, gravimetric, and flotation methods. The use of oleic acid as collector gave high yields of zircon recovery. (auth)

12503 STATUS REPORT ON URANIUM ORE PROCESSING IN AUSTRALIA. Stewart, J. R. (Australian Atomic Energy Commission, Sydney). At. Energy Austral., 10: 12-15 (Jan. 1967).

A report on the production of uranium chemical concentrates in Australia is given. Of the five plants constructed from 1954 to 1959 only one is in operation at the present time, and two are kept on a "care-and-maintenance" basis. Details of each plant are given, and problems involved in mining uranium ore in Australia are discussed. (D.H M.)

12504 ECONOMICAL CHARACTERISTICS OF FUEL REPROCESSING PLANTS AND REPROCESSING CHARGES. Inoshita, Makoto (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 39, 254-9(Jan. 1966). (In Japanese).

Fuel reprocessing costs were studied analytically for two groups of atomic power stations, light-water reactors and Magnox reactors. The reprocessing plants were constructed and operated entirely by private enterprises. Based on the original investment in plant facilities, the cost of fuel reprocessed for Magnox reactors is about a third of that reprocessed for light water reactors. The reprocessing cost per KWh(e) for the Magnox reactor is about twice that for a light-water reactor of the same capacity, but the reprocessing cost per ton of fuel is about $\frac{1}{2.5}$. Reduction in the reprocessing cost is achieved by constructing reprocessing plants economically and operating them at a high rate. Light water reactors will also benefit more from new fuel-reprocessing charges than will natural uranium reactors. (NSA of Japan)

12505 EXTRACTION OF PLUTONIUM FROM URANIUM–PLUTONIUM ALLOY WITH URANIUM TRICHLORIDE. Chellew, N. R.; Steunenberg, R. K. (Argonne National Lab., Ill.). Nucl. Appl., 3: 142-6(Mar. 1967).

The reaction $UCl_3 + Pu \rightleftharpoons PuCl_3 + U$ was examined by measurement of the redistribution of plutonium after equilibration of molten uranium alloys containing 0.2 to 4.2% Pu with UCl_3 diluted with $CaCl_2$. Equilibrium constants for the reaction, calculated from the experimental results, were about 200 at 1150°C and 170 at 1200°C. For reactants equilibrated at 1200°C, the loss of Pu by vaporization was small (≈1% of the initial concentration in the alloy during a 30-min reaction period), and the contamination of the metallic ingot by reaction with BEO containment crucibles was negligible. The experimentally derived equilibrium constant for the reaction at 1200°C was used to predict the extraction of plutonium from uranium containing 1 to 4% Pu. The calculated extraction was sufficiently large to show promise for the application of chloride slagging techniques to the processing of metallic breeder blanket material. (auth)

12506 REMOVAL OF RADIOSODIUM INTERFERENCE IN NEUTRON ACTIVATION ANALYSIS. Menon, M. P.; Wainerdi, R. E. (Texas A and M Univ., College Station). pp 152-6 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

A simple and rapid radiochemical procedure for the removal of radiosodium from neutron-activated biological and oceanic samples is discussed. This method is essentially based on the precipitation of carrier and active sodium as sodium chloride from a solution of the sample by a n-butanol–HCl mixture. This procedure not only removes active sodium but also reduces the chlorine activity to a negligible level. The effectiveness of ^{24}Na

removal from various biological and sea water samples activated with reactor neutrons is demonstrated. If the concentration of the trace element is in the submicrogram range, the trace element may not be detected after the removal of ^{24}Na in samples containing a significant amount of potassium. At least four different trace element activities were detected in various samples after the removal of ^{24}Na alone. This procedure is most useful to measure activities with half-lives ranging from a few hours to a few days where ^{24}Na interference is a serious problem. (auth)

12507 LARGE PLANTS FOR SALT WATER CONVERSION. Standiford, F. C.; Bjork, H. F. (Badger Associates, Inc., Ann Arbor, Mich.). Chem. Eng. Progr., 63: 70-9(Jan. 1967).

The use of long tube vertical (LTV) type evaporators in desalination plants is reported. A comparison of the STV evaporator and the multi-stage flash (MSF) evaporator is made. The falling-film version of the LTV evaporator was chosen for the demonstration plant at Freemont, Texas, and the MSF process was chosen for San Diego plant. Topics discussed are: design of Freeport plant; scale prevention; plant performance; cost comparisons; advantages of LTV process; difficulties at Freeport; corrosion; feed distribution; successes at Freeport; second-generation plants; process improvements; feed sequence; equipment improvements; energy sources; third-generation plants; design features; and plant costs. (D.H.M.)

12508 THE METROPOLITAN WATER DISTRICT DESALTING PROJECT. Galstaun, L. S. (Bechtel Associates, New York); Currier, E. L. Chem. Eng. Progr., 63: 64-9(Jan. 1967).

The results of the conceptual design and cost analysis of a large dual-purpose seawater conversion and nuclear power generating plant for the Metropolitan Water District of Southern California are reviewed. Attention was directed principally to the desalination plant and to those features of the nuclear power plant that were unique for a dual-purpose plant. (D.H.M.)

12509 OFFICE OF SALINE WATER MODULE PROGRAM. Sieder, E. N. (Office of Saline Water, Washington, D. C.). Chem. Eng. Progr., 63: 59-63(Jan. 1967).

The Office of Saline Water module program is discussed with reference to small-, intermediate-, and large-size plants. Some of the topics covered are the design of the module, some of the scale up features of the design, and what is expected from tests on the module. (D.H.M.)

12510 DESALTED WATER AS A COMPETITIVE COMMODITY. Ennis, C. E. (Catalytic Construction Co., Philadelphia). Chem. Eng. Progr., 63: 54-8(Jan. 1967).

The principal economic parameters of water supply from several possible sources are discussed in an effort to show that desalted water is competitive today with water from conventional sources. It was concluded that since desalination is a proven and feasible technology available today, it should be evaluated on the same basis as the other potential water sources when a new water supply is sought. Some factors favorable to desalination as the optimum solution to many of today's water needs are high quality, full-year seasonal reliability, and potentially close physical relation of source to point of use. (D.H.M.)

12511 SEPARATION OF URANIUM ISOTOPES ACCORDING TO THE SEPARATION JET PROCESS. Becker, E. W.; Bier, K.; Bier, W. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 39: No. 1, 1-7(Jan. 1967). (In German).

A separation-jet process, based on the partial spatial demixing of components of different mass in an expanding ultrasonic jet stream, is reported. It is of interest for the separation of uranium isotopes. The economic aspect of the process was considerably improved by increasing the mach number, by mixing the uranium hexafluoride with a light gas, and by increasing the angle of deflection of the flow planes with a bent deflection plate. Optimum process conditions are reported and the minimum specific costs achieved are compared with those of the diffusion process. (auth)

12512 EFFECT OF THE COMPOSITION OF ORGANOPHOSPHORUS COMPOUNDS ON THE EXTRACTION OF CEROUS NITRATE. Orlov, Yu. F.; Shvedov, V. P. Radiokhimiya, 8: 139-45(1966). (In Russian).

Quantitative data were obtained, on the extraction of cerous nitrate with fifteen organophosphorus compounds of various structures. The distribution of ^{144}Ce was studied without adding a carrier under equilibrium conditions at 25°C, with benzene as the diluent. The distribution coefficients of cerium were determined by measuring the activity of both phases. It is shown that in the extraction of Ce^{3+} by phosphates and phosphonates, the inductive effect of the substituents is of decisive importance. In many cases, however, steric factors have a substantial influence. It was found that the relation between log K (K being the extraction constant of Ce^{3+}) and the frequency of vibrations of the P=O bond of the extractants is only very roughly linear. (JPRS)

12513 ADSORPTION OF LONG-LIVED RADIOACTIVE FISSION PRODUCTS OF URANIUM BY NATURAL ADSORBENTS. REPORT NO. 1. ADSORPTION OF ^{90}Sr BY GEORGIA BENTONITES. Kharaidze, P. V.; Kalandiya, A. A. Tr. Gruz. Politekh. Inst., No. 1, 67-75(1965). (In Russian).

The adsorption of ^{90}Sr without a carrier by natural bentonite adsorbents was studied, and preliminary experiments were carried out on the adsorption of ^{90}Sr with bentonite activated with aqua regia and its desorption with nitric acid of various concentrations. In the adsorption equilibrium, the amount of $^{90}Sr-^{90}Y$ adsorbed by natural bentonite amounted to 68.8%, and the amount adsorbed by bentonite activated with acid was 97.2%, for an activity of 1 ml of the initial solution of 50,000 dpm and at a 50:1 ratio of liquid phase to solid phase. $^{90}Sr-^{90}Y$ is almost completely removed from the water by acid-activated bentonite. Following establishment of equilibrium between ^{90}Sr and ^{90}Y (after standing for 14 days), the percent adsorption and distribution coefficient do not change, i.e., ^{90}Sr is adsorbed to the same extent by the bentonite samples. This may be explained by the presence of sulfates and hydroxides, mainly of metals of group I, in the adsorbent. A virtually complete desorption (98.6 to 99.4%) of $^{90}Sr-^{90}Y$ from the bentonite at 20 to 25°C with agitation for 30 min takes place when it is treated with a 1 to 1.5N solution of HNO_3. (JPRS)

12514 SORPTION OF METALS FROM AN ACETATE SOLUTION BY SKT ACTIVATED CHARCOAL. Kuzin, I. A.; Taushkanov, V. P.; Leonov, B. M.; Boganch, Ya. Zh. Prikl. Khim., 39: 359-62(1966). (In Russian).

The sorption of Zr, Cr, Cd, Zn, Pb, Mn, Ni, Co, U, Ba, and Cs by activated charcoal from solutions of acetic acid and ammonium acetate was studied. It was found that U is more readily sorbed by the charcoal than any of the other metals. The optimum mixture of acetic acid and ammonium acetate for the sorption of U is 0.45 mole acetic acid and 0.05 mole ammonium acetate. Addition of the latter to the acetic acid solution immediately increased the sorption by the charcoal; however, continued increase in the concentration of ammonium acetate beyond 0.05 mole reduced the sorptive capacity of the charcoal exponentially. It was found that NH_4NO_3 in a solution of pH 2.4 to 3.0 slightly increased the sorptive capacity of charcoal above a salt concentration of 1 mole/dm^3. Experimental data was obtained on a bed of charcoal 60 mm high. Passage of the acetate solution through the bed occurred at a rate of 1 $cm^3/cm^2 \cdot min$. (JPRS)

12515 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF GLASS BODIES. Grover, John Roger; MacKenzie, Malcolm. (to United Kingdom Atomic Energy Authority). British Patent 1,050,818. Dec. 7, 1966. Filed Sept. 17, 1963.

A process is described for the production of glass bodies suitable for fixation of radioactive wastes for disposal. The glass bodies are formed by melting borax, silica, and waste oxides, the radioactive mixture of oxides obtained from the waste or effluents resulting from treatment to remove U and Pu from irradiated U and then casting the melt into suitable shape and size. To insure leach-resistant properties, a suitable mixture for the formation of the glasses is 40 wt % borax, 20 wt % SiO_2, and 40 wt % waste oxides. After melting the combined oxides, the glass may be formed into any convenient shape or size. An automatic device is described for melting the glasses and casting the melt into spherical solid bodies. (B.L.M.)

12516 PROCESS OF SEPARATION OF URANIUM AND THORIUM STARTING FROM A SOLUTION CONTAINING THESE TWO ELEMENTS. Huet, H.; Lorrain, C.; Mariette, R.; Mahut, R.; Vertes, P. (to Commissariat a l'Energie Atomique). Canadian Patent 748,363. Dec. 13, 1966. Priority date Feb. 14, 1964, France.

The aqueous feed solution which may contain widely varying proportions of the two elements as nitrates, is extracted with tributylphosphate in an organic medium such as kerosene. Suitable control brings the uranium concentration in the organic phase close to saturation. The next step is scrubbing with acidified uranyl nitrate. The latter contains complexing ions for thorium. A solution of uranyl nitrate is recovered from the organic phase with thorium content below 50 ppM. Evaporation of the other portion of the solution yields thorium nitrate crystals with low impurities. (F.S.A.)

12517 METHOD FOR SEPARATING AND CONCENTRATING ISOTOPES. Fujiwara, Shizuo. Japanese Patent 1966-1680. Feb. 7, 1966. Filed Mar. 30, 1961.

A method is proposed for separating and concentrating certain isotopes in which a compound of a certain element is irradiated with ionizing radiation, such as deuterons, protons, neutrons, electrons, X, gamma, photons, and other electromagnetic radia-

tions. The method is particularly applicable to compounds of nitrogen, and the volatile (gaseous) decomposition products that result are collected to obtain ^{15}N. (NSA of Japan)

12518 RECOVERY OF ZIRCONIUM COMPOUNDS FROM ALKALI METAL ZIRCONIUM SILICATES. Meyer-Simon, Eugen; Frey, Artur (to Deutsche Gold- und Silber-Scheideanstalt vormals Roessler). U. S. Patent 3,281,207. Oct. 25, 1966. Priority date Oct. 26, 1961, Germany.

A process is described for the recovery of Zr values from alkali metal Zr silicates by reaction with acids to decompose the silicates to form silicic acid and a soluble Zr compound. The silicate is mixed with a combination of HCl and H_2SO_4, such as to provide 2 moles HCl per mole of alkali metal oxide and 1.5 to 2.2 moles of HCl per mole of ZrO_2 and 0.5 to 0.8 moles of H_2SO_4 per mole of ZrO_2 in the starting silicate. The mixture is heated to a temperature between 90 and 110°C with stirring until the filterable silicic acid has separated out. The silicic acid is subsequently filtered off leaving the soluble Zr values, and the filtrate is neutralized and heated to effect precipitation of the basic zirconium sulfate. (B.L.M.)

12519 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF HEAVY WATER. (to Commissariat a l'Energie Atomique). British Patent 1,050,125. Dec. 7, 1966. Priority date Nov. 15, 1963, France.

An apparatus and process are described for the production of heavy water by the countercurrent isotope exchange process in two exchange zones at different temperatures between a current of liquid water, which is the deuterium source, and a current of H_2S gas, which is the exchange medium. The aqueous phase is enriched in deuterium in the lower-temperature exchange zone and the gaseous phase is enriched in deuterium in the higher-temperature zone. The apparatus includes a hot tower and a cold tower for effecting the exchange with means for recycling the deuterium-impoverished H_2S from the cold tower to the hot tower via means for saturating the H_2S with water. A degasification tower is provided for removing H_2S from the water from the hot tower. The water is passed from the hot tower through a heat exchanger for heating prior to the removal of H_2S from the water and then the water passes through an expansion valve to the degasification tower. Means are provided also for heating the water that is used to effect saturation of the H_2S gas. A boiler is provided for the production of superheated steam, which passes through a turbine for expansion then to a first heat exchanger for heating the water from the hot tower prior to the removal of H_2S from the water in the degasification tower and finally to a second heat exchanger for heating the water that is used to effect saturation of the H_2S gas. (B.L.M.)

12520 METHOD FOR THE PURIFICATION AND RECOVERY OF SOLVENTS USED IN REPROCESSING NUCLEAR FUEL. (to Japan Atomic Energy Research Inst.). British Patent 1,051,978. Dec. 21, 1966. Priority date May 22, 1963, Japan.

A process for the purification and recovery of solvents containing TBP used in reprocessing nuclear fuels comprises passing the used solvent through an OH-type anion exchanger to remove impurities such as dibutyl phosphate and monobutyl phosphate and complexes of these with nuclear fission products, which exist in anionic form in the solvent and circulating the purified TBP/diluent mixture to the reprocessing plant for use again in reprocessing fuels. The lower phosphates collected in the exchanger can be eluted with a 1N caustic soda solution so that the exchanger can be used over again. It is difficult to remove the complexes from the exchanger, so spent exchanger must be handled and disposed as radioactive solid waste. If solid particles are suspended in the used solvent, pretreatment, such as filtration, centrifugal separation, or one-stage chemical washing is necessary before the solvent is passed over the exchanger column. (B.L.M.)

EARTH SCIENCES

Geology

Refer also to abstract 12536.

12521 (UCRL-17061) RADIOACTIVITY OF UPPER MESOZOIC GRAYWACKES IN THE NORTHERN COAST RANGES, CALIFORNIA. Wollenberg, Harold A.; Smith, Alan R.; Bailey, Edgar H. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 12, 1966. Contract W-7405-eng-48. 34p. (CONF-661118-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Geological Society of America Meeting, San Francisco, Calif.

Traverses across the Coast Ranges north of San Francisco were made to measure the field gamma radioactivity and to sample graywackes of the Franciscan formation, its Coastal Belt unit and the Great Valley sequence. Specimens were analyzed for U, Th, and K by gamma spectrometry; K-feldspar contents were determined by point-counting stained slabs. The K-feldspar content has little effect on radioactivity or heat production of the rock units. Low K-feldspar content does not indicate low heat generation; therefore, low temperature–high-pressure metamorphism is not related to K-feldspar content. Radioactivity tends to decrease with increasing metamorphic grade. Thorium/uranium ratios fall within the range described by Adams and Weaver (1958) as typical of eugeosynclinal sediments, and are like Th/U ratios in granitic rocks of the Sierra Nevada, the suggested source area. Uranium, Th, and K concentrations of the graywackes are compatible with those of a cratonal source. When the heat-production values are combined with heat-flow measurements now being obtained, the thicknesses of the sedimentary columns and the effect of the rocks' radiogenic heat on the observed geothermal gradient may be calculated. (auth)

12522 COUNTER DIFFUSION OF ^{86}Rb AND ^{89}Sr IN COMPACTED SOIL. Phillips, R. E.; Brown, D. A. (Univ. of Arkansas, Fayetteville). J. Soil Sci., 17: 200-11(Sept. 1966).

Counter-diffusion coefficients of ^{86}Rb and ^{89}Sr counter diffusing against H ions were measured in Dundee silt loam and Sharkey clay soils at differing soil bulk-densities. The cation exchange complex of each soil was saturated with either Rb^+, Sr^{2+}, or H^+ and washed free of salts from making diffusion measurements. The water content of the soil on an oven-dry weight basis was maintained at a constant value for all bulk-densities; 14.2 and 28.0% for the Dundee and Sharkey soils respectively. These moisture contents corresponded to a tension of $^2/_3$ bar for sieved soil. The diffusion coefficients were dependent upon concentration. Average counter-diffusion coefficients were calculated and related to soil bulk-density. Soil compaction of Dundee silt loam had little or no effect upon the counter diffusion of ^{86}Rb. The average counter-diffusion coefficients of ^{89}Sr in Dundee silt loam and Sharkey clay were significantly and linearly related to bulk-density; as bulk-density increased the average counter-diffusion coefficients increased. The average counter-diffusion coefficients were ~0.5 to 0.75 of the corresponding self-diffusion coefficients measured previously in these soils. The applicability of counter- and self-diffusion data to practical field problems is discussed. (BBB)

12523 STUDIES IN THE PROVIDENCIA AREA, MEXICO. III. NEUTRON ACTIVATION ANALYSES OF FLUID INCLUSIONS FROM NOCHE BUENA. Puchner, Herbert F.; Holland, Heinrich D. (Princeton Univ., N. J.). Contract AT(30-1)-2266. Econ. Geol., 61: 1390-8(Dec. 1966).

Fluid in inclusions in four samples of quartz from the Noche Buena mine, Zacatecas, Mexico, has been analyzed by means of a neutron activation technique. The samples were irradiated prior to extraction of the fluid from the inclusions in order to minimize contamination. The concentration of sodium in the inclusion fluids ranged from 0.8 to 1.8 percent, and their manganese content ranged from 50 to 170 ppm. Neither copper nor zinc was detected. Studies of the detection limits of the analytical techniques used indicated that the concentration of copper was less than 12 to 24 ppm and that of zinc less than 260 to 580 ppm in all of the inclusion fluids. The inclusion fluids analyzed were almost certainly saturated with respect to chalcopyrite and sphalerite at the time of entrapment. Therefore, at least some hydrothermal solutions in equilibrium with these minerals contain only small concentrations of copper and zinc. (auth)

12524 THE CARBON, HYDROGEN, AND OXYGEN ISOTOPIC COMPOSITION OF THE HYDROTHERMAL FLUIDS RESPONSIBLE FOR THE LEAD-ZINC DEPOSITS AT PROVIDENCIA, ZACATECAS, MEXICO. Rye, Robert O. (Geological Survey, Denver). Econ. Geol., 61: 1399-1427(Dec. 1966).

The relative deuterium concentration of water in primary fluid inclusions in calcite, quartz, and sphalerite from several mines at Providencia, Zacatecas, Mexico, was determined to fall in the narrow range −6.8 to −8.3%. Essentially the same range was obtained for each of the three minerals throughout the area and for fluid inclusions having a wide range of filling temperatures and salinities. Detailed studies of the carbon and oxygen isotopic composition of four successive calcite generations from three mines indicate only small variations in the isotopic composition of individual generations. Successive generations of calcite, with one exception, have increasingly heavier carbon and oxygen isotopic compositions. This trend coincided with a 150°C decrease in the temperature of mineral deposition. The results can be interpreted to indicate that the oxygen isotopic composition of the hydrothermal fluid was nearly uniform in time and space during ore deposition, and that the trend toward higher $\delta^{18}O$ values with time was a result of increasing isotopic fractionation as temperatures of deposition decreased. The results also indicate that the isotopic composition of carbon from the source of the fluids was uniform throughout calcite deposition, and that the trend toward higher $\delta^{13}C$ values with time for the bulk of calcite deposition was the result of either increasing isotopic fractionation of carbon with decreasing temperature, or the mixing of limestone carbon with deep-seated carbon, or both. The oxygen isotopic composition of the hydrothermal fluids was calculated from the isotopic composition of the calcites, the filling temperatures of the fluid inclusions, and experimental fractionation factors. Results show that the bulk of the calcites precipitated from fluids having an oxygen isotopic composition between 6.4 and 7.9%. Similar calculations based on the oxygen isotopic composition of quartz fall within the range calculated from the calcite data. The isotopic data are interpreted in terms of the origin and history of the hydrothermal fluids that were responsible for the ore body. The isotopic data strongly point to a magmatic source for the hydrothermal water, and to a deep-seated source for at least 50 percent of the carbon in the calcites. The large salinity variations in the Providencia fluid inclusions, from 5 to 40 equivalent weight percent NaCl, resulted either from events at the source of the fluids, or from intermittent incorporation of sedimentary salt. (auth)

12525 POTASSIUM, RADIUM, AND THORIUM CONTENTS IN CAUCASIAN SOILS. Brendakov, V. F.; Iokhel'son, S. V.; Churkin, V. N. Pochvovedenie, No. 1, 41-7(Jan. 1967). (In Russian).

The distribution of natural radioactive elements in the upper layer of Caucasian soils is discussed. A method of collecting and analyzing soil samples is described. Schematic maps of potassium, radium and thorium distribution in the upper layer of Caucasian soils are presented. (auth)

12526 GROUND WATER RECHARGE OF AQUIFERS AS REVEALED BY NATURALLY OCCURRING RADIOCARBON IN VENEZUELA. Tamers, M. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Nature, 212: 489-92(Oct. 29, 1966).

The use of naturally occurring radiocarbon as a means of investigating ground water movement is described. When water enters the ground it carries with it a certain amount of CO_2. The CO_2 reacts with limestone to form bicarbonate. Limestone, which contains virtually no ^{14}C, dilutes the isotope in dissolved carbonate and so produces apparent radiocarbon ages for ground water which are greater than the actual ages. The method used for the correction of radiocarbon ages consists of the assumption that the amount of limestone dissolved is equivalent to one half of the bicarbonate present and that the carbon from plants and the atmosphere is the equivalent of one half the bicarbonate plus all the dissolved CO_2. Using the concentrations of these two carbonate species, an estimate of the amount of limestone dissolved is possible. (R.C.K.)

Meteorology

Refer also to abstracts 12286 and 12546.

12527 (AERE-R-5260) RADIOACTIVE FALLOUT IN AIR AND RAIN: RESULTS TO THE MIDDLE OF 1966. Cambray, R. S.; Fisher, E. M. R.; Brooks, W. L.; Peirson, D. H. (Atomic Energy Research Establishment, Harwell (England). United Kingdom Atomic Energy Authority, Capenhurst (England). Production Group). Nov. 1966. 48p. Dep. BIS $1.40. HMSO 7s. 0d.

Samples of atmospheric dust and rainwater have been collected

from the United Kingdom and overseas. Results are presented of the analyses of these samples for various fission products and certain other radionuclides. The concentrations of the long-lived fission products Cs-137 and Sr-90 in air and rain over the United Kingdom were, in the first half of 1966, about 40% of those for the first half of 1965. The average deposition of Cs-137 and Sr-90 in the United Kingdom for the first six months of 1966 was about 55% of that for the corresponding period of 1965. The third Chinese explosion of 9th May 1966 temporarily contributed about 2% to the long-lived activity. An estimate is made of the total global deposition of Sr-90 in rain to the end of 1965. The effective age of long-lived fission product debris in the two hemispheres is now similar although the deposition of Sr-90 still continues significantly lower in the southern hemisphere. Concentrations of short-lived fission products from the Chinese test of 9th May 1966 and the French tests of July–October 1966 are given in an appendix. (auth)

12528 (COO–1340-9) ROLE OF THE TROPOPAUSE IN STRATOSPHERIC–TROPOSPHERIC EXCHANGE PROCESSES. Atmospheric Science Paper No. 107. Reiter, E. R.; Glasser, M. E.; Mahlman, J. D. (Colorado State Univ., Fort Collins. Dept. of Atmospheric Science). Jan. 1967. Contract AT(11-1)-1340. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In a previous study Reiter and Mahlman estimated the amount of stratospheric air intruding into the stable layer of the jet stream front in a case of cyclogenesis not accompanied by surface radioactive fallout. The same case is examined on a more general basis. Outflow from, as well as inflow into, the stratosphere is estimated over the entire thickness of the "tropopause gap." (auth)

12529 (GA–7058) HENRY'S LAW CONSTANTS FOR DISSOLUTION OF FISSION PRODUCTS IN A SILICATE FALLOUT PARTICLE MATRIX. Norman, J. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 29, 1966. Contract N0022866CO403. 47p.

Henry's Law constants for fission product elements and important activated elements are estimated for the system: dilute element, 1 atm oxygen pressure, and liquid silicate solvent. A lower oxygen pressure limit for use of these values is also presented. These constants may be used to calculate solubility of fission products in fallout as a function of temperature. In conjunction with diffusivities, half-lives, yields, and detonation parameters, these constants can be used to calculate fractionation effects in fallout. A simple estimating scheme is given for describing fission-product distribution and fractionation in fallout. (auth)

12530 (UCRL–50007-66-1, pp 11-14) ATMOSPHERIC STABILITY MEASUREMENTS AS AN AID IN DISASTER PLANNING. Lindeken, C. L.; Beard, E. L.; Lakin, R. W. (California Univ., Livermore. Lawrence Radiation Lab.).

The capacity of the atmosphere to dilute and disperse contaminants released into it is governed by its vertical temperature profile. The equipment used to obtain this profile is described and the data now being collected are discussed. The equipment consists of towers (~100 ft.), thermistors, and signal cables. (B.G.D.)

12531 (UCRL–50007-66-1, pp 41-3) SEASONAL VARIATIONS IN THE CONCENTRATION OF AIRBORNE RADON AND THORON DAUGHTERS. Lindeken, C. L. (California Univ., Livermore. Lawrence Radiation Lab.).

Concentrations of airborne radon and thoron daughters at Livermore, California were measured twice daily, Monday through Friday, from May 1965 until May 1966. Samples were taken 5 ft above ground at flow rates of 3 cfm for 60 min periods. The daughter products were collected on Millipore SM filters, and the activity counted with a solid state detector. Both the radon daughter and thoron daughter concentrations were greater in the morning than in the afternoon. Both concentrations showed a marked increase in September, October, and November. The degree of concentration was a function of air movement. High concentrations are a good index of atmospheric stability. (L.C.L.)

12532 SURVEY OF RADIOACTIVE FALLOUT, ANNUAL REPORT FOR 1965. Kang, Man Sik; Chung, Hack Pil. Kisul Yon Guso Pogo, 4: 50-3(1965). (In Korean).

Activity of radioactive fallout for 1965 was measured with following results: gross beta-activity of rain water varied from 7.6×10^{-4} μCi/liter to 10^{-5} μCi/liter with a mean value of about 10^{-4} μCi/liter; gross beta-activity of fallout dust ranged from 3.6×10^{-3} μCi/m^2-day to 10^{-5} μCi/m^2-day and was about 10^{-4} μCi/m^2-day on an average; and total dry deposition was about 100 mCi/km^2-year which was about 900mCi/km^2-year lower than that of last year. General behavior of fallout radioactivity during the year showed a spring peak in March and April and gradually decreased toward the end of the year with another peak in May. This high value probably was due to Red China's nuclear detonation of May 14 which was detected on May 16. The value was 10 times as high as that of April and lasted for about a week. (auth)

12533 SURVEY OF RADIOACTIVITIES IN FIELD WATER AND SOIL. Park, Woo Hyun; Lee, Eal Hyung; Kim, Sung Bong; Lee, Moo Ung. Kisul Yon Guso Pogo, 4: 57-9(1965). (In Korean).

Radioactivities in field water and soil were measured in 1965. Results showed that: gross beta-activities in field water ranged from 19.3×10^{-5} μCi/l to 0.16×10^{-5} μCi/l and no appreciable differences from the average of ~10^{-5} μCi/l compared with those of underground water were found; gross beta-activities of soils ranged from 25.06×10^{-4} μCi/100gr to 0.44×10^{-4} μCi/100gr and was ~10^{-4} μCi/100gr levels on the average; and higher activities appeared in the first half year. (auth)

12534 DISTRIBUTION WITH DEPTH OF RADIOACTIVE PARTICLES IN IRON METEORITES. Lavrukhina, A. K.; Revina, L. D.; Ibraev, T. A.; Yukina, L. V. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 1, 20-30(Jan. 1967). (In Russian).

Calculations of the distribution of radioactive particle intensity with the depth in an iron slab of 260 cm thickness (x = 260 cm) and in iron meteorites of spherical form and of preatmospheric radius R_1 = 2.5 to 200 cm have been carried out. Weighted average cross-sections of the primary cosmic radiation absorption and of the inelastic interaction of radioactive secondary particles in a certain energy range are determined. The average number of secondary particles generated in nuclear interactions by primary particles with a 0.1 + 14 BeV energy is calculated. Shift in the energetic spectra in the meteorites with depth caused by energy loss by charged particles for ionization was determined using the range-energy ratio for copper. Intensity change curves for primary radiation and for various components of the secondary radiation for slow, fast neutrons, shower particles, protons, $\pi^{\pm}$-mesons and for summary intensity have been obtained depending on the absorber depth. The distribution character of the primary and secondary radiation is conditioned by secondary neutrons and chiefly by slow ones. The flux of radioactive particles reaches its greatest intensity at a depth of ≈15 cm, then an abatement occurs being chiefly conditioned by the absorption of particles interacting with iron nuclii. Various characteristics of the intensity distribution with the depth of radioactive particles in iron meteorites are considered. (auth)

12535 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 44, JANUARY–MARCH 1966. Taiki Hoshano Kansoku Seiseki, No. 44, 1-78(Jan.-Mar. 1966).

Data are reported on the results of routine observations of fallout during the period from January to March, 1966, including measurements of temporary standard samples, U_3O_8; mean and observed radioactivity in rainwater collected at fixed times daily; radioactivity in airborne dusts; and radioactivity measurements in sea water. (R.C.K.)

12536 VARIATIONS IN AMBIENT RADIATION AS A RESULT OF FALLOUT DEPOSITS CLOSE TO THE GROUND. Fett, W. (Freie Univ., Berlin). Atompraxis, 12: 559-63(Nov. 1966). (In German).

Several years' local measurements of ambient radiation are compared with the fallout activity which accumulated on the ground. The portion of the ambient radiation which does not derive from cosmic radiation or from the natural nuclides in the soil, in buildings, or in precipitation shows short-term and long-term variations which fairly closely parallel those of fallout activity accumulated on the ground. The most important exceptions are those resulting from the absorbent effect of layers of snow, and those apparently resulting from the vegetation rhythm, which causes an annual cycle in the distribution of fission-product deposits. (auth)

12537 NUCLEAR TECHNIQUE IN TRACING THE CUMULI CLOUDS. Kyriazopoulos, B. D.; Livadas, G. C.; Dimotakis, P. N. Pure Appl. Geophys., 64: 248-53(1966).

Within the scopes of Mount Olympus Cumulus Project which is currently in progress on the summit of Mount Olympus (Hellas), a new method has been applied, with nonradioactive tracers, which would become radioactive afterwards by neutron irradiation at the "Democritus" (Athens) nuclear reactor. To this effect the solution of the tracers (various chemical compounds) was injected into the cumuli clouds by spraying it in the form of small droplets by means of an airblast nozzle type agricultural sprayer. After tracing, samples of the cloud were taken by means of a filter paper connected with a high volume air sampler. (auth)

12538 RHYTHMIC CIRCULATION OF WAVES OF FISSION PRODUCTS FROM THE RED CHINESE ATOMIC BOMB TEST (9 MAY 1966). Fett, Walter (Freie Univ., Berlin). Berlin. Wetterkarte, Suppl. 141/66, 3p(Aug. 31, 1966). (In German).

Fallout recorded in Berlin from April to July 1966, was related to the particle concentration in the lower stratosphere above the measurement site, air exchange between the lower stratosphere and the upper troposphere, inclusion of particles during formation of fallout, and rainout and decay of particle activity occurring since the fission process. The recorded variations can be corrected for decay in order to ascertain the chronological sequence of appearance and decay of the Chinese atomic bomb test of May 1966. Values obtained are proportional to the cloud particle concentrations as long as they are not influenced by exchange between troposphere and stratosphere. The max appear to be defined as 3 peaks that are related to a time of movement around the earth of ~20 days, taking into account the distance between the test site and the measurement sites. Collectively, the peaks have a relative variation of ~16%, which agrees with a dissipation of the cloud with time in a translational direction. The absolute chronologically increasing dispersion results in an increasing spreading of the max. Exchange in the upper atmosphere causes other max. The size relations of the max are also altered by the unexpectedly small particle concentrations in the first wave of fission products. The fission products of the first cloud wave cannot be isolated quantitatively from the background of the older products. The transversal dissipation was initially small. Other factors that appear to have influenced the atmospheric fission product concentrations that resulted from the May 1966, bomb test are discussed. These take into account horizontal cloud streaming conditions, vertical exchange, and assumed particle concentration ratios. (BBB)

Mineralogy

12539 (RT-GEO-(66)-4) MICRODETERMINAZIONE SELETTIVA DELL'URANIO E DEL TORIO NELLE ROCCE E NEI MINERALI MEDIANTE AUTORADIOGRAFIA. UTILIZZAZIONE DEL METODO SU ALCUNI CONCENTRATI DI MINERALI DETRITICI. (Autoradiographic Method for Selective Microdetermination of Uranium and Thorium in Minerals. Utilization of the Method for Classification of Detrital Mineral Concentration). Gioria, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 40p. (In Italian). Dep. mn.

Autoradiographic methods have been used in order to distinguish and classify some types of detrital minerals of different provenance and genesis, determined during the mineralogic prospection. With such methods diagnostic studies and correlations have been also performed, in order to single out the mother rocks of these detrital minerals. The preliminary methodologic researches accomplished on this subject are described. With the purpose of distinguishing U from Th polyester absorbers that allow alpha particles of the ThC′ (Polonium-212) isotope of the thorium family to be selected have been used. The method has also been used to distinguish uranium from thorium in monazite concentrates of alluvial samples from some Calabria rivers. (auth)

12540 ^{234}U FRACTIONATION IN THE SANDSTONE-TYPE URANIUM DEPOSITS OF THE AMBROSIA LAKE DISTRICT, NEW MEXICO. Dooley, J. R. Jr.; Granger, H. C.; Rosholt, J. N. (Geological Survey, Denver). Econ. Geol., 61: 1362-82 (Dec. 1966).

Isotopic analyses for ^{234}U were made on 30 samples from 5 vertical suites of ore-grade uranium-bearing sandstone from the Ambrosia Lake district, McKinley County, New Mexico. ^{238}U, ^{235}U, and ^{234}U were measured by mass spectrometry, and $^{234}U/^{238}U$ ratios were verified by alpha spectrometry. No $^{238}U/^{235}U$ isotopic variations were found above the ½ percent level of accuracy of these measurements. Uranium-234 variations were as great as 58 percent deficient and as much as 36 percent enriched as compared to the radioactive equilibrium value attained in a reference sample of Republic of Congo pitchblende. The pattern of ^{234}U fractionation found for both primary ore (classified as pre-fault) and redistributed ore (post-fault) samples generally shows and enrichment just above the ore and a large relative deficiency near the richest uranium ore. Samples taken above the water table show another enrichment in ^{234}U at the bottom boundary of the ore but samples taken below the water table do not. This pattern of ^{234}U fractionation can be explained by assuming that the uranium was redistributed and ^{234}U was gradually enriched at the boundaries of mineralization except where the lower boundary is below the water table. Samples from two vertical suites believed to be redistributed ore show the greatest deficiency in ^{234}U with respect to the reference standard. Radiochemical analyses of ^{230}Th and ^{231}Pa indicate a complicated history of uranium migration in the deposit, significant redistribution of uranium having occurred during the last 200,000 years. The distribution of ^{230}Th and ^{231}Pa indicates that interphase isotopic exchange of uranium was the predominant mechanism producing ^{234}U enrichment, although deposition of ^{234}U enriched uranium from solution can be a contributing factor. Leaching of uranium apparently prevails more commonly where ^{234}U is relatively deficient, but uranium deposition is indicated in a few samples that have a deficiency of ^{234}U. (auth)

Oceanography

12541 URANIUM CONTENT IN CASPIAN SEA SEDIMENTS. Baturin, G. N. At. Energ. (USSR), 21: 515-16(Dec. 1966). (In Russian).

Recent studies indicated that Black and Baltic Sea sediments are enriched in uranium up to 1 to 3×10^{-6}%, although the concentration of the sea water, as that of the Pacific Ocean, ranges from 2 to 3×10^{-6} g/l. This was attributed to a direct or indirect effect of hydrogen sulfide in the water; on the other hand, the sorption equilibrium between the uranium content of the water and the sediment may cause deposition of this element if a certain concentration of the water is exceeded. This assumption was examined by determining the uranium concentration of the deposits of the Central Caspian Sea, the waters of which are free from hydrogen sulfide. The uranium content of 34 argillaceous and slightly calcareous specimens from deep regions was found to lie between 1.0×10^{-4} to 2.3×10^{-3}%. The highest concentrations were encountered in the clayey silts from the middle section of the Central Caspian basin; the lowest were found at the Western ledge. In the delta of the Volga River, the dissolved uranium exceeded the amount found in the suspension but in the turbid Caucasian rivers the relation was reversed. Analysis of the post-quaternary deposits indicated that the uranium reached the basin primarily as detrital particulate matter; the role of the dissolved uranium was negligible in this respect. (TTT)

12542 URANIUM AND MINOR METALS IN COLUMNS OF BOTTOM SEDIMENTS OF THE BLACK AND MEDITERRANEAN SEAS. Baturin, G. N.; Kochenov, A. V.; Shimkus, K. M. Geokhimiya, No. 1, 41-50(Jan. 1967). (In Russian).

In columns of sediments of the Black and Mediterranean seas U, Mo, Co, Ni, V and C may be distributed in the same way as organic matter. In the Black sea a correlation with organic matter is more obvious for U and Mo while in the Mediterranean all the metals have a small difference in this relation from each other. Because of absence of any connection between organic matter and Mo, Co, Ni and V in the surface layer of silts the observed correlation is explained by diagenetic redistribution. (auth)

Seismology

12543 (AD-640212) COLLECTION AND ANALYSIS OF SEISMIC WAVE PROPAGATION DATA. Final Report. Report No. 5178-64-F. Willis, David E.; Jackson, Philip L. (Michigan Univ., Ann Arbor. Inst. of Science and Technology). Aug. 1966. Contract AF 49(638)-1170. 103p. CFSTI $3.00 cy, $0.65 mn.

Four years of theoretical and applied research on propagation of seismic waves and techniques for analyzing data are summarized. Coherent optical processing techniques for analyzing seismic data were investigated and evaluated. Linear mode filtering, employing Fourier techniques, of seismic data was developed; it permits separating linear from elliptical ground motion. Frequency-analysis techniques involving optical, analog computer, digital computer, and active electronic filters were developed and evaluated. Radiation patterns from the regions of cylindrical and elliptical sources were investigated. Source motion was studied, using data from short-distance compressional waves. Theoretical studies of the scattering caused when an incident wave encounters an elliptical obstacle were conducted; both near-field and far-field effects were determined. A preliminary analysis of long-range refraction profiles obtained between Lake Superior and the Atlantic Ocean disclosed that anomalies in travel time and amplitude occur across the Michigan Basin and Appalachian Mountains. The anomaly across the Basin is substantiated by recordings of NTS events. A seismic-well monitoring station of intermediate depth was designed and put into operation; it reduces by a factor of ten microseismic background noise at frequencies above 1 cps. A processor to convert large-aperture seismic array (LASA) digital information into analog form was designed and partially constructed. (TAB)

12544 RAYLEIGH WAVE DISPERSION AND CRUSTAL STRUCTURE FROM RUSSIAN NUCLEAR EXPLOSION OF 30 OCTOBER 1961. De, U. S. (Central Seismological Observatory, Shillong, India). Indian J. Meteorol. Geophys., 17: 457-6(July 1966).

Data obtained from nuclear explosions can be used for the determination of crustal structure by using fundamental and M_2 Rayleigh waves. The Russian nuclear explosion of 30 October

1961, was the largest of the series and gave rise to well-developed surface waves of fundamental and M_2 mode, which were recorded by the vertical component of the Press–Ewing long period seismograph (T_0 = 15 sec and T_g = 90 sec) at New Delhi. Observations on the fundamental mode Rayleigh waves and a study of the average crustal structure between Delhi and Novaya Zemlya are reported. The origin time 08 hr 33 min 33 sec was used for the determination of phase and group velocities. The observed periods were in the range 39 to 22 sec. The Rayleigh wave dispersion was computed by the graphical method of Press and Ewing. The crests and troughs of wave groups were plotted against arrival times and the slope of the curve was used for the determination of period at successive points. The arrival time at these points was used to compute velocity of the waves. The group velocity varied from 3.28 to 2.92 km/sec and the phase velocity from 3.92 to 3.56 km/sec. Theoretical curves were plotted for a 2-layered crust with a sedimentary layer at the top overlying a semi-infinite isotropic half space. The observed values of the group and phase velocities fell between the theoretical curves for 35 km and 45 km and were closer to the higher thickness value of the crust. The similar results from both phase and group velocity demonstrated the soundness of the method used and of the assumption that explosions are compression type sources which means that all the spectral components generated by the explosion are in phase as troughs at the origin. The group velocities were also compared with the data obtained by Pomeroy from nuclear explosion for a path Agra to Novaya Zemlya and a close agreement was seen. These comparisons indicate that the average crustal thickness between Delhi and Novaya Zemlya is of the order of 45 km. (BBB)

ENGINEERING

Nuclear Explosions

12545 (AD–640428) CRITICAL RADIANT EXPOSURES FOR IGNITION OF TINDER AND COMBUSTIBLE MATERIALS. PART I. WOOD. (Naval Applied Science Lab., Brooklyn, N. Y.). Jan. 15, 1965. 22p. (DASA–12009). CFSTI $3.00 cy, $0.65 mn.

Wood in six different forms was exposed to thermal radiation from simulated nuclear weapons pulses in the range from 65 kilotons to 100 megatons. Sawdust from weathered wood was most readily ignited, glowing ignition occurring at 6.4 cal/sq cm for a 65 kt pulse, and at 21 cal/sq cm for a 100 Mt pulse. Clean, unseasoned douglas fir, one-half-inch thick, was ignited to sustained flaming at radiant exposures of 31 and 68 cal/sq cm for yields of 1.2 and 108 Mt, respectively. Weathered douglas fir could be ignited only to short-lived afterglow which extinguished itself shortly after exposure. Yellow poplar, clean, $\frac{1}{16}$-inch thick, was ignited to sustained flaming at 33 and 71 cal/sq cm for pulses simulating weapon yields of 1.2 and 108 Mt, respectively; excelsior ignited at 29 and 53 cal/sq cm for the same pulses. Sustained flaming of the unseasoned douglas fir is a significant finding which is contrary to previous experience. The heavy resin content of the specimens studied in these tests is obviously a factor. (TAB)

12546 (PNE–225F) PROJECTS 62.86 AND 62.80. PART I. CHARACTERISTICS OF FALLOUT FROM A DEEPLY BURIED NUCLEAR DETONATION FROM 7 TO 70 MILES FROM GROUND ZERO. PART II. AERIAL RADIOMETRIC SURVEY. Project SEDAN. Mork, Harold M.; Larson, K. H.; Kowalewsky, B. W.; Wood, R. A.; Paglia, D. E.; Rhoads, W. A.; Guillou, R. B. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). July 1966. Contract AT-04-1-GEN-12. 118p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Adequate samples of fallout from the detonation of a nuclear device buried in desert alluvium at 635 feet below ground surface were obtained to delineate the eastern part of the fallout pattern from 7 to 70 miles from ground zero. The distribution of radioactivity per unit area, mass per unit area, and mass per unit area per particle size fraction were determined. No correlation between radioactivity and mass was found. The time of arrival of fallout and radiation intensity histories were recorded by field radiation detection instruments. Considerable differences occurred in time of arrival of fallout and its duration across the fallout pattern beyond 20 miles from ground zero. Radioactive decay of samples from five laterals of the fallout pattern showed negative slopes of about 1.4 for the time interval from H + 48 to H + 600 hours. Enough shear of the cloud occurred to permit a comparison of the isotopic fractionation existing above 10,000 feet MSL; but the data are limited to incomplete results from only five samples, one from each lateral, submitted to NRDL. The radiochemical analyses indicated a distance relationship and provided evidence of fractionation that substantiated a difference between the fallout debris from two levels of the cloud. The data indicated that topography had a significant influence on the activity per unit mass, the particle size distribution and the fractionation of the fission product nuclides. The Aerial Radiometric Surveys determined the distribution of Sedan fallout to a distance of more than 200 miles from ground zero. The dose rate contours show the pattern to be asymmetric with a steep gradient west of the midline with a very gradual gradient on the east. (auth)

Facilities and Equipment

Refer also to abstracts 12604, 12615, 12860, 12868, and 13469.

12547 (N–66-33505) DEVELOPMENT OF ELECTRICAL SWITCHGEAR FOR SPACE NUCLEAR ELECTRICAL SYSTEMS. Quarterly Progress Report No. 6, March 4–June 4, 1966. Powell, A. H. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). [1966]. Contract NAS3-6467. 78p. (NASA-CR–72014). CFSTI $3.00 cy, $0.65 mn.

Assembly of the first breaker and contactor was completed, the units were installed in the ultrahigh vacuum test tank, and testing was initiated. The heat run and high potential check was completed, and the endurance test started, with full rated current flowing in the switchgear. The leak which developed in the ceramic capsules was subsequently reduced by use of a sealing fluid to the point where the attached ion pump would maintain the vacuum while under room conditions. Therefore, two capsules were used to complete the ac breaker and dc contactor for the heating and endurance tests. At the same time, the leak problem was reviewed in detail and the design was modified to improve the joints between the ceramic and metal spinning. New ceramic seal assemblies were ordered for use in the subsequent interruption tests. (STAR)

12548 (N–66-33975) RANKINE CYCLE TEST FACILITY STUDY: TECHNICAL DATA. Final Report. Wettach, R. H. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Aug. 1966. Contract NASw-943. 505p. (NASA-CR–54972). CFSTI $3.00 cy, $0.65 mn.

Requirements of a facility to be used for testing liquid metal Rankine cycle components were analyzed in a preliminary study. Study areas included: vacuum environmental requirements, loop and facility materials, loop design, conversion of a space power chamber for testing of the facility, instrumentation needed, loop start-up procedure, and conditions (electrical output, fluid temperature, loop fluid, etc.) for the testing. Results of the study indicate that the design and construction of a 15 megawatt (thermal) test facility consisting of three liquid metal loops (a primary lithium liquid loop in which the lithium is heated to 2200°F, a secondary potassium vapor working loop in which the vapor is generated at 2050°F, and a NaK liquid radiator loop in which the liquid is heated to 1395°F) is feasible and entirely within the present day state of the art and capability of industry. The conversion of the space chamber for the testing of the facility is also considered feasible. Problem areas are discussed. FS-85 niobium alloy is recommended as the liquid metal containment material. The total time required to design, build and install the facility is estimated at 48 months. A schedule is given. In addition, specifications for materials, equipment, procedures, and assemblies are given.(STAR)

12549 (N–66-39615) ANALYSIS OF TOPPING AND BLEED TURBOPUMP UNITS FOR HYDROGEN-PROPELLED NUCLEAR ROCKETS. Evans, David G.; Crouse, James E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1960. 45p. (NASA-TM-X–384). CFSTI $3.00 cy, $0.65 mn.

The turbopump units analyzed were a bleed, a hot-topping (full-flow turbine), and a cold-topping unit. The types of configuration required and their effect on rocket gross weight were investigated. The scope of the analysis did not include the effects of the turbopump configurations on the weights of associate components, such as the reactor. (STAR)

12550 (RFP–864) VERSATILE ELECTRON BOMBARDMENT EVAPORATION SOURCE. Beno, R. L.; Van Vorous, T. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 13, 1967. Contract AT(29-1)-1106. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A versatile electron bombardment heated evaporation source was developed. This device may be used with many types of crucible materials selected for use with a particular metal. It is capable of use in an inverted direction with wire feeding of an evaporant metal. (auth)

12551 (UCRL–50007-66-1, pp 46-9) DYNAMIC METHOD FOR PRODUCING KNOWN CONCENTRATIONS OF GAS AND SOLVENT VAPOR IN AIR. Nelson, G. O.; Griggs, K. S. (California Univ., Livermore. Lawrence Radiation Lab.).

An apparatus, designed to generate known concentrations of solvent vapor and gas in air over a wide range of concentrations for calibration work, is described. A mechanically driven syringe is used to inject known amounts of either solvents or gases to produce concentrations ranging from 2 to 5000 ppM for solvents and from 0.01 to 1000 ppM for gases. The concentrations produced were verified by both gas chromatographic and chemical techniques. The accuracy, compactness, and flexibility of this device makes it a highly desirable calibration apparatus for an industrial hygiene laboratory. (L.C.L.)

12552 (UCRL–50007-66-1, pp 50-2) CALIBRATION OF EJECTORS FOR USE IN AIR SAMPLING. Cohen, J. J.; Toy, A. J. (California Univ., Livermore. Lawrence Radiation Lab.).

Three air ejectors were calibrated for use in air sampling. Performance curves were plotted for each ejector with a range of compressed air pressures from 30 to 80 psi. The vacuum flow rate for any air sampler may be easily determined from these curves. Two features of the system are noted: in some cases, more air can be sampled than is expended to power the ejector, and the loss in flow rate due to dust loading is minimized. (L.C.L.)

12553 (UCRL–50007-66-1, pp 53-4) PORTABLE GLOVED-BOX EXHAUST SYSTEM. Harder, C. A. (California Univ., Livermore. Lawrence Radiation Lab.).

A portable exhaust system for maintaining the required negative pressures in glove boxes is described. (L.C.L.)

12554 (UCRL–50007-66-1, pp 55-6) A VERSATILE, STEAM-DETERGENT DECONTAMINATION GUN. Taylor, R. D.; Kvam, D. J. (California Univ., Livermore. Lawrence Radiation Lab.).

A steam-detergent gun with interchangeable nozzles for decontaminating radioactive surfaces is described. (L.C.L.)

12555 (Y–1566) ELECTRONIC FRINGE SIGNAL DETECTION CIRCUITRY FOR LENGTH-MEASURING INTERFEROMETERS. Henry, J. J.; Groppe, W. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 9, 1967. Contract W-7405-eng-26. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An electronic signal-conditioning system has been designed for use with laser-actuated length-measuring interferometers. Many improvements have been incorporated in this design to provide extended frequency response, stability, and operator convenience. These improvements allow "shop" use of the interferometer by nontechnical personnel for inspection and machine-tool control. Test results obtained from four prototype systems demonstrate the capability of the design. Maintenance and operating procedures are included for both the electronic and optical systems. (auth)

12556 GAMMA-RAY IRRADIATION FACILITY FOR BIOCHEMICAL RESEARCH. Hatano, Hiroyuki (Kyoto Univ.); Ganno, Shigetake; Sumizu, Koichiro; Ohnishi, Shunichi; Kimura, Nobuaki; Imai, Takeshi; Tsuzuki, Tadaichi. J. Radiat. Res. (Jap.), 7: 67-82(June 1966).

A gamma-ray irradiation facility with a 100 Ci cobalt-60 source was designed as a unit type for use in radiation biochemistry, and installed in the Department of Chemistry, Kyoto University in 1963. This facility is able to achieve irradiation at moderate dose rates of the range from 6×10^3 to 5×10^4 roentgens per hour and is easily manipulated manually. The facility was equipped with a temperature control system and a circulating system for flowing liquid materials during exposing to gamma ray irradiation. (auth)

12557 FOOD PRESERVATION BY IRRADIATION IN THE WORLD. Comit. Naz. Energ. Nucl., Notiz., 12: No. 8-9, 69-81(Aug.-Sept. 1966). (In Italian).

Current activities in the investigation of food preservation by irradiation in the major countries of world are reviewed. Radioisotopic sources and other equipment, including mobile irradiation units are described. Results of research on fruits, vegetables, fish and meats are summarized. (F.S.)

12558 FUEL ELEMENT LEAK DETECTOR MODULE (Engineering Materials). (Argonne National Lab., Ill.). (CAPE–1538).

7 drawings.

A small hydraulically or pneumatically actuated valve is described. The valve controls fluid flow of liquids or gases by expanding or relaxing an O-ring within an annular flow space. (For details see TID-4100 Supp 38.) (F.S.)

12559 HANDLING TOOLS USED WITH THE ADVANCED TEST REACTOR (Engineering Materials). (Idaho Operations Office (AEC), Idaho Falls). (CAPE–1518).

17 drawings.

Handling tools and equipment for fuel elements, control rods, and special tubes used for experiments at the Advanced Test Reactor are described. These include storage racks, spent fuel casks, a canal transfer device, reflector lifting tool, plier head, wrench, snare tool, pole hoist tool, pole hoist tool strain gage, and a flux wire tool. (For details see TID-4100 Suppl. 38). (F.S.)

12560 HANDLING TOOLS USED WITH THE ENGINEERING TEST REACTOR (Engineering Materials). (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). (CAPE–1517).

4 drawings.

Handling tools used in the Engineering Test Reactor are described. These include a 20 ft finger which opens to a 1⅝ in. gap; a ten foot long snare, rope actuated with a ⅛ in. wire loop 3 in. ID and three plier heads. These are a ⅜ in. to 1½ in.; a 1 in. to 2 in. and a ⅜ in. to 2 in. which is hydraulically operated. For other handling tools for the Engineering Test Reactor see CAPES-163 and -164. (For details see TID-4100 Suppl. 38). (F.S.)

12561 GENERAL PRECISION DISC INTERFACE (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1533).

18 drawings.

Driver and receiver printed cards designed to interface between 0 and −10V and 0 and −3V logic levels are described. The circuit is designed to drive a 75 Ω coaxial cable terminated at both ends exterior to the card. Each circuit consists of a simple inverter with a terminator at the input followed by an emitter-follower stage. The emitter follower is used to obtain reasonable rise, fall and delay times for the relatively large currents (250 ma) in the output circuits. Delay-time plus rise-time (or fall time) from input to output is less than 70 ns. The terminator eliminates ringing on the cable. The inverter is equipped with an anti-breakdown diode and an anti-saturation diode. Delay time plus fall time measured from the input of the first stage to the output of the second stage is less than 40 ns. (For details See TID-4100 Suppl. 38). (F.S.)

12562 ETR PROCESS WATER IODINE MONITOR (Engineering Materials). (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). (CAPE–1506).

4 drawings.

The filters, cation columns and flow diagrams used for iodine monitoring in the process water of the Engineering Test Reactor are described. Iodine content is read on the control panel attached to the Tracerlab Fission Products water monitor. The water leaving the primary cooling system passes through the filters to the cation column. The filters consist of filter paper and a back up of stainless steel 40 linear mesh wire screens 3⅜ in. in dia. The cation columns, enclosed in lead brick shields, are fabricated from 18.8 stainless steel. The columns are 12 in. high with a 1⅝₂ in. OD and 1¾₄ in. ID with 60 mesh 18.8 stainless steel screens 1¼ in. dia at the top and the bottom of the column. (For details see TID-4100 Suppl.38). (F.S.)

12563 LIFTING MECHANISM. Cabaret, Jean; Gerard, Victor; Valentin, Andre (to Commissariat a l'Energie Atomique). British Patent 1,054,839. Jan. 11, 1967. Priority date Oct. 1, 1963, France.

A lifting mechanism used in a nuclear reactor facility to lift covers of tanks or leak-tight vessels used to transfer radioactive materials is described. The lifting mechanism is designed so that upward travel is accomplished in two stages. The cover is lifted vertically while remaining parallel to the plane of the opening. In the second stage, the cover is removed so as to free the opening. The first stage permits the material from the liquid seal to drip into the vessel and not be dispersed. (F.S.)

12564 TRANSIT FLASK FOR RADIOACTIVE OBJECTS. Brebant, Charles (Commissariat a l'Energie Atomique). British Patent 1,055,818. Jan. 18, 1967. Priority date Dec. 6, 1963, France.

An air-tight shielded container used to protect and transport radioactive objects such as irradiated fuel elements, is described. It consists of a high-density metal casing forming an outer cover for the shielding material. The casing has at least one pocket bounded by a deformable fusible Pb–Sb metal alloy sheet which liquifies at a predetermined temperature and escapes through a Pb–Bi plug forming an expansion volume for the shielding material. (F.S.)

12565 CONTROL SYSTEM FOR A STEAM GENERATOR RECEIVING HEAT FROM A NUCLEAR REACTOR. Weber, M. (to Sulzer Brothers Ltd.). Canadian Patent 746,701. Nov. 22, 1966. Priority date Sept. 12, 1962, Switzerland.

The coolant from a nuclear reactor is used to operate a vapor generator which contains a superheater. The temperature of the coolant is maintained approximately constant by conventional devices and its flow is countercurrent to that in the vapor generator. Steady outlet temperature from the vapor generator is achieved by regulating the rate of feed water supply to the generator in response to the temperature of an intermediate portion of the superheater. A temperature sensor produces a control signal which regulates the supply of feed water. In the vapor generator, there are two sets of coils, the second including a superheater. A system of valves and by-passes maintains control of flow to the turbine. (F.S.A.)

12566 DEVICE FOR HANDLING AND OBSERVING ELONGATED BODIES WHICH EMIT RADIATION. Baudiffer, Guy; Rossetti, Lido (to European Atomic Energy Community). British Patent 1,058,140. Feb. 8, 1967. Priority date Dec. 12, 1962, Belgium.

A device is described which is used in handling and observing elongated bodies which emit radiation such as irradiated fuel rods from a nuclear reactor. The device consists of a sealed enclosure of vertical elongated shape surrounded by an adequate radiation shield with one or more viewing ports. In the enclosure are guides and support mechanisms for supporting and handling the irradiated body or rod. (F.S.)

12567 CONNECTION AND CLOSURE DEVICE FOR A FILTER AND FILTERS INCORPORATING SAME. Cabaret, Jean; Valentin, Andre (to Commisariat a l'Energie Atomique). British Patent 1,058,430. Feb. 8, 1967. Priority date July 12, 1963, France.

A device for connecting and closing a filter unit to avoid pollution or contamination during removal or replacement of the filter is described. The connecting device is used between a filter housing and a fluid delivery sleeve which ensures that the filter housing is closed before the hermetic seal between the housing and the fluid delivery sleeve, which is used to carry the fluids to be filtered, is broken. (F.S.)

12568 IRRADIATION CHAMBERS. (to Sulzer Brothers Ltd.). British Patent 1,055,218. Jan. 18, 1967. Priority date Sept. 8, 1964, Switzerland.

An irradiation chamber is described which has a radiation source which is retractable into a shielding block which forms part of the roof of the chambers. The source is housed in a number of cylindrical capsules connected by articulated joints. The source is retractable in a helical passage in the shielding block. The source is connected to the retracting mechanism. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 12603 and 14048.

12569 (AAEC-TM-331) AN EXAMPLE OF SPHERE BRIDGING IN A CIRCULAR CHANNEL. Scott-Rogers, L. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1966. 14p. Dep. mn.

A bridged system of spheres in circular channels with a channel-to-ball dia ratio of 4.7 is examined. The basic bridge structure consists of two diametric arches at about 60° relative displacement. Associated with these arches is a stable hexagon ring of spheres and a central sphere held at five contact points. (auth)

12570 (AECL-2646) EFFECT OF COSINE AND HALF-COSINE HEAT FLUXES ON DRYOUT FOR STEAM–WATER FLOW IN AN ANNULUS AT 1000 PSIA. Abraham, S. C.; Macdonald, I. P. L.; Moeck, E. O.; Wikhammer, G. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1966. 34p. Dep. mn. AECL $1.00.

The dryout heat flux (critical heat flux at high steam qualities) and location of dryout on a rod having a non-uniform axial heat flux profile can be explained in terms of liquid film flow. For two-phase inlet conditions, a liquid film forms on the upstream, unheated rod (dummy) and flows onto the heater. If this film flow is small, (short dummy), droplet deposition governs dryout which then occurs upstream of the heated end, for a half-cosine (flux-decreasing) heat flux profile. If this film flow is significant, (long dummy), dryout occurs at the downstream end. The film flow model postulated earlier for uniform heat fluxes successfully describes dryout for the present experiments. It was found that the earlier uniform flux data cannot be used on a "local conditions" basis to predict dryout on the non-uniform flux heaters. "Integrated conditions," that is, dryout power vs. inlet quality, successfully predicts the dryout power for the half-cosine heaters but overestimates the power for the cosine heaters by about 20%. (auth)

12571 (AERE-M-1825) A FORTRAN PROGRAMME FOR THE PROCESSING OF PERMEABILITY DATA IN POROUS MEDIA. Huber, R. A.; Roberts, J. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1966. 16p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

A computer programme PERCOLATED which was developed for the processing of permeability data for various gases in porous media at temperatures between 0 and 700°C, is described. It contains two novel criteria for the exclusion of non-correlating data. Viscosity and molecular weight data for most of the common gases used in permeability determinations are incorporated in the programme, which may readily be modified to include other gases. The programme is written in the FORTRAN (S2) language for the IBM 7030 (STRETCH) computer at AWRE, Aldermaston. (auth)

12572 (APED-5295) TURBULENT FLOW IN ECCENTRIC ANNULI. Rogers, A. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1966. 41p.

Thesis. Submitted to Univ. of California, Berkeley.

Equations describing fully developed turbulent flow in an eccentric annulus are derived. The methods used are extensions of concentric annulus theory. The predicted shear distributions for the inner and outer walls, velocity distributions, and friction factor results are compared with available data, and are found to be in good agreement with most experimental results. An extension of the analysis to include infinite rod arrays is proposed. (auth)

12573 (GEAP-5300) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. Eighth Quarterly Progress Report, July 26–October 25, 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1966. Contract AT(04-3)-189. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The test section and instrumentation for the nine-rod steam-water tests for studies of two-phase flow and heat transfer in multirod geometries were made ready. Salient dimensions of the test channel are: channel inside dimension, 2.347 in., channel corner radii, 0.325 in., rod outside diameter, 0.528 in., rod-to-rod, 0.225 in., rod-to-wall, 0.155 in., and heated length, 72 in. The channel is fitted with three isokinetic probes, three shear probes, and porous segments on the exit end of three of the rods for the purpose of measuring liquid film rate. Peripheral instrumentation for pressure and sample rate and enthalpy measurement is also provided. A calibration curve for the Preston-type shear probe in high-pressure steam-water indicates that the same calibration curve applies for two-phase as for single-phase flow. (auth)

12574 (N-66-39722) TRANSIENT DYNAMICS AND THERMAL STRESS FOR NUCLEAR ROCKET HEAT-EXCHANGER. Liu, T. C.; Shen, C. N. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Mechanical Engineering). Sept. 7, 1966. 77p. (NASA-CR-78947). CFSTI $3.00 cy, $0.65 mn.

The equivalent one-dimensional approach for the transient heat transfer problem in a nuclear reactor is discussed in detail. From this approach, the temperature distribution of fuel element and coolant channel are obtained in simple form and with sufficient accuracy. The transient thermal stresses are proportional to the difference of temperature between the fuel element and coolant channel. The analytical solutions of the thermal transient and stresses are given for a sudden change of the hydrogen flow. From several numerical examples, it is shown that the transient thermal stresses can be much higher than the steady-state full power thermal stresses. The maximum transient to steady-state full power thermal stresses should be limited to a proper ratio to ensure that the design of the reactor is within the margin of safety. (STAR)

12575 (SAN-677-3) INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS. Quarterly Report, July 11–September 30, 1966. Poppendiek, H. F.; Feigenbutz, L. V.; Greene, N. D.; Sabin, C. M.; Connelly, D. J. (Geoscience Ltd., Solana Beach, Calif.). Contract AT(04-3)-677. 43p. (GLR-47). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Liquid metal boiling studies applicable to Rankine Cycle Systems are described. Analytical time histories of the vapor film thicknesses under vaporizing mercury and water drops positioned above a hot surface are compared to heights of asperities typical of representative heat transfer surfaces. These comparisons aid in explaining transition region boiling behavior. A study of microgeometry of practical heat transfer surface materials is presented; asperity heights and spacing are compiled and analyzed. A literature review reveals the importance of the influence of impurities or additives on droplet vaporization. Information on the design of the environmental chamber to be used to study the influence of surface geometry, surface chemistry, liquid metal impurities, inert gas contents, etc., on the boiling of mercury droplets is presented. The experimental procedures to be used are reviewed. The results of some preliminary water and Freon 11 droplet vaporization lifetimes are presented for smooth and rough heat transfer surfaces under similar wall-saturation temperature difference conditions. A study is made of the error in the initial drop temperature as it is released from a reservoir which is at a prescribed saturation temperature. A preliminary design has been completed of a multi-tubed boiler test section which will be used to study forced flow boiling mercury heat transfer for different types of boiler materials. Specifically, Croloy 9M, Haynes 25, columbium and copper test sections are to be investigated. (auth)

12576 (SC-M-66-623) PROCEEDINGS OF JOINT ATOMIC ENERGY COMMISSION/SANDIA LABORATORIES HEAT PIPE CONFERENCE HELD AT ALBUQUERQUE, NEW MEXICO, JUNE 1, 1966. VOLUME I. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 91p. (CONF-660645). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The conference was divided into two sessions during which papers discussing theoretical analyses, development procedures, and a variety of applications for heat pipes were presented. Volume II contains the classified papers. Topics covered in Volume I include status of the engineering theory of heat pipes, heat pipe capability experiments, operating limits of heat pipes, liquid transport and heat transfer properties of heat pipe wicking materials, feasibility studies of space radiators using vapor chamber fins, and heat pipes and vapor chambers and their application to thermal control of spacecraft. (W.D.M.)

12577 (TID-23394(Vol.2)) LOW PRESSURE STEAM-WATER FLOW IN A HEATED VERTICAL CHANNEL. Final Report Volume II on A Study of Convection Boiling Inside Channels. Ferrell, J. K.; Bylund, D. M. (North Carolina State Univ., Raleigh. Dept. of Chemical Engineering). June 1966. Contract AT(40-1)-2950. 266p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The characteristics of boiling water mixtures flowing through a vertical, small diameter, uniformly heated channel under forced circulation were studied. Quantitative measurements and qualitative observations were made of the flow patterns. A wide range of

heat fluxes, flow rates, and inlet temperatures was covered in the 60 to 240 psia range. System variables were chosen to permit an evaluation of the effects of each upon the measured and observed two-phase behavior. In the analyses of the results, a constant slip ratio model was proposed for the density distribution in the bulk boiling region of the channel and an empirically derived correction was made to qualities calculated from heat balances to account for lack of thermodynamic equilibrium between the vapor and liquid phases. The correction method was tested on 1200 to 2000 psia heated rectangular channel data from the literature. Density distributions predicted by this method were in excellent agreement with reported high pressure experimental data. At pressures below 800 psia, a strong flow rate dependence was noted in the constant slip ratio values. This phenomenon will require additional experimental data to fully understand. Within the limits of the system variables covered in this research, and in boiling channel data in the literature, it was concluded that the ability to predict the true local quality values is a powerful and necessary tool for prediction of density distributions in these channels. The assumption of constant slip ratios in the slug and churn flow regimes was proven correct when the appropriate quality correction was made. Observed flow patterns were compared to two methods from the literature for predicting flow pattern transitions. The drift velocity-distribution parameter method of Zuber and co-workers was found to be at least qualitatively in agreement with these low pressure heated channel results when no quality correction was made, but failed when the necessary quality corrections were made. The assertion of Griffith that churn to annular flow regime transitions occur at constant quality in adiabatic channels, was confirmed for heated channels. The Martinelli-Nelson method of predicting two-phase pressure drop was found to result in low predictions compared to measured values. Strong flow rate and heat flux dependencies were noted in the local and overall friction multipliers. Sher's flow rate correction correlation was found to be inadequate to accommodate the former dependency for the system variables covered in this research. Referencing the experimentally derived local and overall friction multipliers to corrected quality demonstrated much less scatter in the multiplier values than did those referenced to equilibrium quality. Photographs of the observed flow patterns in an adiabatic extension of the heated channel have been included together with a tabulation of the experimental data, and a description of the experimental facility and techniques. (auth)

12578 (TID-23394(Vol.3)) TWO-PHASE FLOW THROUGH ABRUPT EXPANSIONS AND CONTRACTIONS. Final Report Volume III on A Study of Convection Boiling Inside Channels. Ferrell, J. K.; McGee, J. W. (North Carolina State Univ., Raleigh. Dept. of Chemical Engineering). June 1966. Contract AT(40-1)-2950. 230p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pressure drop and void fraction data were obtained for adiabatic two-phase flow through sudden expansions and contractions using the system steam-water. In addition, pressure drop and void fraction data were also obtained for a limited number of adiabatic, uniform diameter channels. The data were obtained for vertical upflow of steam-water mixtures in tubular channels. Sudden expansions with area ratios of 0.332, 0.546, and 0.608, sudden contractions with area ratios of 0.546, and 0.608 and uniform channels of 0.460-inch and 0.340-inch diameters were investigated. The range of variables encompassed pressures from 60 to 240 psia, mass velocities from 67 to 506 lb/ft^2-sec and qualities from subcooled conditions to 0.32. For the uniform diameter channels it was found that a definite correlation existed between the slip ratio and the flow regime. In general, the slip ratio increased with quality in the slug and churn flow regimes, reached a maximum at a quality near that predicted for the transition from churn to annular flow, and decreased as the quality increased in the annular flow regime. Pressure changes across a sudden expansion were satisfactorily predicted by a theoretical equation when measured values of the void fraction were used in the analysis. In contrast, pressure changes across sudden contractions predicted by a theoretical equation, using measured void fractions, were much lower than experimental values. However, pressure drop results predicted by assuming void fractions equal to those for homogeneous flow compared reasonably well with experimental values even though the actual void fractions were significantly less than the homogeneous values. A satisfactory explanation of this result was not achieved. (auth)

12579 (TID-23652) A HEAT TRANSFER INVESTIGATION OF EJECTOR SYSTEMS WITH 90^0 TURNS, NERVA PROGRAM. (Aerojet-General Corp., Sacramento, Calif.). Nov. 1964. Contract SNP-1. 25p. (RN-DR-0038). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are presented from a test program that evaluated the heat transfer characteristics of a series of ejector systems that turned the rocket exhaust gases through 90°. The ejector systems covered a range of designs that utilized both subsonic and supersonic turning of the gases within a fixed height. A series of tests with heated nitrogen was made for each ejector, during which measurements of local pressures and wall temperatures were made to provide the data necessary to evaluate the heat-transfer conditions. The results from three of these systems are discussed to illustrate the differences in thermal behavior that can be obtained during the turning of the gases. The maximum heating rate was reduced by a factor of 7 when the ejector had a long radius, as compared to a short radius 90° turn and by a factor of 5 by permitting the gases to shock down to subsonic flow prior to entering the short radius bend. A method of converting the scale-model heat-transfer coefficient data to any other scale size, working fluid, nozzle chamber temperature or chamber pressure and an empirical correlation of the maximum heating rates is presented. (auth)

12580 (USNRDL-TRC-86) HEAT TRANSFER FROM RADIOISOTOPIC HEAT SOURCES BURIED IN THE OCEAN FLOOR. Schrock, V. E.; Kesavan, K. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 2, 1966. Contract AT(49-5)-2084. 53p. Dep. mn.

Experiments to determine the release to sea water of radioisotopes contained in various nuclear power devices are described. The modes of heat transfer from isotopic heat sources buried in sands on the ocean floor are found to be free convection or nucleate boiling. Data are presented on temperatures of the capsule surface and temperature distribution in the surrounding sand. Permeability, porosity and thermal conductivity of Monterey sand was determined. (F.S.)

12581 EXPERIMENTAL LOCAL HEAT-TRANSFER AND AVERAGE FRICTION COEFFICIENTS FOR SUBSONIC TURBULENT FLOW OF AIR IN AN ANNULUS AT HIGH TEMPERATURES. Dalle Donne, M.; Meerwald, E. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Heat Mass Transfer, 9: 1361-76 (Dec. 1966).

Experimental local heat-transfer and friction coefficients are correlated for subsonic turbulent flow of air through a high temperature annulus (maximum wall temperature: 1000°C) with long unheated entrance length. Equations are given for the local heat transfer and friction coefficients averaged in the central portion of the annulus. (F.S.)

12582 GENERAL NON-CIRCULAR DUCT CONVECTIVE HEAT-TRANSFER PROBLEM FOR LIQUIDS AND GASES. Tyagi, V. P. (Indian Inst. of Tech., Kanpur). Int. J. Heat Mass Transfer, 9: 1321-40(Dec. 1966).

A theoretical study of the heat transfer by steady laminar forced convection in non-circular ducts was made. The region of cross-section of the duct under consideration is simply connected and bounded by an arbitrary non-circular closed curve. An arbitrary additional heat source distribution is assumed to be present within the fluid medium. The thermal boundary condition used is that the wall temperature varies linearly in the axial direction. Including viscous dissipation and work of compression in the thermal energy balance, the most general solution has been given in terms of integral formulas both for gases and liquids by using the technique of conformal mapping. General power series solution has been given for the case of gases only. For demonstration, the case of Cardioid duct with additional heat source distribution of constant intensity has been investigated numerically. Out of the mathematical work, only final results have been presented, and the description of methods has been deleted. To investigate the qualitative as well as the quantitative effects of viscous dissipation in the case of liquids, and those of viscous dissipation jointly with work of compression in the case of gases on heat transfer due to constant axial temperature gradient, is the principal object of the present study, and the emphasis also has been mainly given to this. It is found that the said effects are qualitatively remarkable, and usually significant quantitatively also under the condition of constant physical properties; which is a common simplification in a large number of heat-transfer studies. It is also concluded that if viscous dissipation and work of compression are significant in the heat-transfer problem of the present paper then the free convection effects thereby are insignificant. (auth)

12583 PARTICLE TRANSPORT AND HEAT TRANSFER IN GAS-SOLID SUSPENSION FLOW UNDER THE INFLUENCE OF AN ELECTRIC FIELD. Min, Kun (Lowell Technological Inst., Mass.); Chao, B. T. Nucl. Sci. Eng., 26: 534-46(Dec. 1966).

An experimental investigation has been carried out demonstrating the feasibility of improving wall-to-fluid heat transfer in solid-gas suspension flow in which the solid particles were electrically charged and were acted upon by forces due to a fluctuating electric

field, normal to the flow stream. The suspension, consisting of 30-μ glass beads in air, flowed vertically downward in a rectangular heat-transfer channel. The flow Reynolds number ranged from 1460 to 5840 and the loading ratio from 0 to slightly above 2. An alternating potential of 10-kV peak-to-peak was applied across the half-channel width of 0.635 cm. At the frequency of 7.7 cycles/sec and the loading ratio of unity, the rate of heat transfer was observed to increase by approximately 30 to 60%, depending on the Reynolds number. It was shown that the increase in heat transfer can be largely accounted for by the heat conveyed by the particles from the heated wall to the flow stream. Under certain simplifying assumptions, the increase in heat flux was expressed in terms of the particle influx at the wall and the degree of accommodation of the particles to the wall and fluid bulk temperatures. The principal simplifying feature of the system was the dominant influence of the applied field on the particle transport behavior. (auth)

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Refer also to abstracts 12556, 12580, 12609, and 13127.

12584 (N-66-34606) USING RADIOKRYPTON FOR DETECTION OF LEAKS IN SPACE VEHICLES. Final Report. (Michigan Univ., Ann Arbor). June 15, 1966. Contract NAS8-2579. 34p. (NASA-CR-77304). CFSTI $3.00 cy, $0.65 mn.

A guide for acquiring and using radiokrypton as a leak-detection medium for testing space vehicle systems and related components is presented. Included are a procedure for the dilution of radiokrypton to a usable concentration, charts and graphs indicating leak-rate measurements, which were made with the various types of commercial equipment available, and a sample test procedure using radioactive test gas. (STAR)

12585 (RLO-1951-1) USE OF TRACERS IN IN-PLANT EVALUATION OF PROCESSES AND IN POLLUTION CONTROL OF EFFLUENT FROM PULP AND PAPER MILLS INTO RIVERS. Chatters, R. M.; Peterson, R. L. (Washington State Univ., Pullman). Sept. 1, 1966. Contract AT(45-1)-1951. 8p. (SM-84/18; CONF-661121-1; CONF-661203-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague, Czechoslovakia.

From 8th Annual Atomic Energy Commission's Contractors Meeting, Washington, D. C.

Problems of stream pollution in the pulp and paper industry were studied by following the flow of selected fibers through mill process lines and effluent streams. The use of the radioisotope technique permitted the tagging of fibers and their subsequent identification and tracing without introducing any radioactive material into the mill system. Small amounts of fibers were treated with metallic salts so that the metal component became bonded with the cellulose or was precipitated within the fiber lumen. The treated fibers could be introduced at any point in the mill and dispersed in the mass of fibers already present. Samples of fibers were collected downstream. These samples were irradiated, and then analyzed to detect minute amounts of lanthanum treated fibers in the presence of large masses of untreated mill fibers. This method has been successfully tested in different kinds of mills. (L.C.L.)

12586 (SC-DC-2329) AEROSPACE NUCLEAR SAFETY. Blake, V. E. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 14p. (CONF-661001-38). DTIE.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A standardized procedure which provides a uniform approach to the safety analysis of radioactive space power supplies is discussed. Several factors must be taken into account before radioactive space power supply systems are designed. The mission will determine the power level and lifetime of the power source. The lifetime of the mission may determine the fuel to be used although cost may also heavily influence the selection. The fuel form must be selected, the method of reentry determined, and the disposal approach selected. The procedure consists of the reference design, accident models, and safety analysis. The reference design presents a valid and consistent description of the system, its application and operation. The accident model identifies malfunctions leading to potential nuclear safety problems and relates the probabilistics associated with potential accidents. The safety analysis evaluates the nuclear safety aspects of the system. (F.S.)

12587 (STL-517-0049(Vol.3)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME III. OXIDATION AND DIFFUSION IN NOBLE METAL ALLOY CLADDINGS. Final Report, October 1, 1965-September 30, 1966. Ogren, J. R.; Blumenthal, J. L.; Ham, R. C. (TRW Systems, Redondo Beach, Calif.). Oct. 1966. Contract AT (04-3)-517. 200p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Noble metals were investigated for use as cladding materials to provide long-term oxidation and corrosion protection to refractory metal radioisotope capsules used for Poodle. The kinetics of air oxidation of the rhodium-iridium system of alloys were investigated. The rates of oxidation of the noble metals as a function of alloy composition, temperature, time, and air flow rate were determined. The high-temperature interdiffusion between the Ir-Rh claddings and candidate refractory metal substrate alloys was investigated. Measurements of solidus temperatures, densities, and crystal structures as a function of alloy composition were made. (F.S.)

12588 ELECTROMAGNETIC SEPARATION OF HIGHLY ENRICHED NOBLE GAS ISOTOPES IN MULTIMILLIGRAM QUANTITIES. Hechtl, E.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Nucl. Instrum. Methods, 48: 323-7(1967). (SGAE-PH-44/1966).

A method for electromagnetic separation and for collection of multimilligram-quantities of noble gas isotopes is described. A charcoal collector cooled below 100°K was developed which is capable to store the separated noble gas isotopes during the separation. In a test run it was possible to collect 12 mg ^{131}Xe with an isotopic purity of 99.3%. (auth)

12589 MASS METER FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Dropesky, B. J.; Deal, J. B. Jr.; Buchen, J. F.; Kelley, G. M. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Instrum. Methods, 48: 329-31(1967). (LA-DC-8314).

A mass meter is described for continuous monitoring of beams in an electromagnetic isotope separator. The mass meter indicates a value proportional to $(\frac{1}{2}\ er^2)\ B^2/V$. (B.G.D.)

12590 RADIOISOTOPES FOR AEROSPACE. PART 2. SYSTEMS AND APPLICATIONS. Proceedings of the First Symposium held in Dayton, Ohio, February 15-17, 1966. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966. 474p. $20.00. (CONF-660207-(Pt.II)).

Twenty-seven papers on the uses of radioisotopes for aerospace are presented. Individual abstracts were prepared for 15 papers. Abstracts of 12 papers appeared previously in NSA: see volume 20: 29140, 29142, 31493, 31494, 31495, 31496, 31622, 32347, 32740, 36353, 37064, and 41257. (L.C.L.)

For abstracts of individual papers see: 12591-12605.

12591 HELICOPTER CLOSE-ORDER FORMATION KEEPING SYSTEM. Evans, Howard J. (Industrial Nucleonics Corp., Columbus, Ohio). pp 57-64 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The use of x-ray and gamma sources for maintaining helicopter close-order formation during poor visibility conditions was investigated. Each helicopter is to carry its own source and detector. The system is to operate over a range of 50 to 500 ft, have an accuracy in range of ±10% and in angular measurement of ±5°, be of less than 30 lbs total weight, and provide adequate safety for the helicopter personnel. Stationary and rotating detectors for determining range and angle position are described. A variety of sources for this application are evaluated. It appears that the technique can be refined to achieve the desired control of helicopter flight formations. (L.C.L.)

12592 NUCLEAR RADIATION AS A GUIDANCE TOOL. Wilcox, George E. (Naval Air Development Center, Johnsville, Pa.). pp 65-76 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The feasibility of using nuclear radiation and detection systems for aircraft guidance was investigated, particularly for application to short-range guidance as in helicopter formations. Four guidance methods, each employing a known source but varying in the design of the detection device and read-out system, are compared. A static multi-detector system was considered the best, and has been assembled for future flight testing. (L.C.L.)

12593 RADIOISOTOPE TECHNIQUES FOR THE MEASUREMENT OF VTOL LANDING AND TAKEOFF PARAMETERS. Polishuk, Paul; Beavin, Rudy C. (Wright-Patterson AFB, Dayton, Ohio). pp 102-31 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The problem of control data acquisition during takeoff and landing of VTOL type vehicles is explored. From a brief survey of the required data inputs and performance data for a tactical VTOL aircraft, a tentative landing profile was established. Several nucleonic techniques, which may be used for measurement

of the landing parameters, are analyzed. The radioisotope systems reviewed consist of ground sources and detector packages located in the vehicle. They include rotating-collimator systems and intensity, energy discrimination, and pulse modulation systems. The servoed and rotating collimator systems look the most promising. Further experimental work is needed to determine the accuracy of the system. (L.C.L.)

12594 NUCLEONIC FUEL GAGING SYSTEMS FOR SPACECRAFT. Blincow, Donald W.; Pearson, Keith V.; Ray, Roger A. (Giannini Controls Corp., Duarte, Calif.). pp 132-47 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

An operational spacecraft fuel gaging system based upon the application of radioisotope techniques is described. The elements which comprise the system are: (a) a mapped radioisotope source blanket; (b) a mapped detector blanket which consists of plastic scintillator rods, fiber optic coupling bundles, a photomultiplier tube, and associated electronics; (c) a data processing unit; and (d) a display unit. Each of these elements is discussed in some detail with emphasis being placed upon source and detector blankets. In addition, a discussion on zero gravity effects and the attendant problem of test demonstration of compliance with accuracy requirements in this environment is included. Test results of the system in simulated spacecraft environments, including zero gravity, have demonstrated the predicted results and the accuracy and reliability requirements were met. (auth)

12595 FLIGHT TEST OF A NUCLEONIC TYPE AIRCRAFT FUEL GAGE. Harwick, Burton T.; Hochheiser, Jerome S. (Atomics International, Canoga Park, Calif.). pp 148-61 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A Nucleonic Fuel Gage is described which offers the potential of improved accuracy and reliability and which obviates current major maintenance problems. It also provides for reducing attitude-induced errors associated with gages in present-day usage. The gage design is discussed, beginning with a review of photon interactions in matter and a description of the nature of the signal arising from photon scattering and absorption. Means of utilizing this basic signal are described. A description of the installation of the Nucleonic Fuel Gage on an A4 aircraft is given, along with an indication of the criteria used in selecting the location of radiation sources and scintillation detectors. The instrumentation installed on the vehicle and the techniques used to provide in-flight measurement of Nucleonic Fuel Gage accuracy is described. Ground test calibration data are presented which show gage reading vs actual fuel weight over the range of pitch and roll attitudes achieved in the laboratory (−4° to +12° pitch and 0 to ±2° roll). Flight test data are presented for a flight which is representative of the range of aircraft environments encountered. Gage performance is discussed. (auth)

12596 DEVELOPMENT OF A NUCLEONIC OIL QUANTITY GAGING SYSTEM. Raimondi, E. J. (Wright-Patterson AFB, Dayton, Ohio). pp 162-76 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A nucleonic oil quantity gaging system for continuously measuring the amount of oil in a jet engine during flight is described. The gamma radiation source and Geiger-Mueller detector are mounted externally on the oil tank, and the detector output is converted to voltage impulses which are displayed on a meter indicator. Two companies built prototypes which were flight tested on an F-104A aircraft. These test results demonstrate that a continuous nucleonic oil-quantity gaging system is practical, reliable, provides a degree of accuracy not available with other methods, and, since it is outside the oil tank, can be used with a variety of oil tank configurations. (L.C.L.)

12597 NUCLEONIC TWO PHASE HYDROGEN QUALITY GAUGING SYSTEM. Fornadley, Frank D. (General Nucleonics Corp., Claremont, Calif.). pp 177-84 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A nucleonic gaging system for accurately measuring the mass of flowing two-phase hydrogen is described. Beta emitting sources were mounted in a fixed configuration in the hydrogen flow pipe. Ten solid state detectors were arrayed outside the flow pipe. The output of the detectors is combined electronically to give an integrated output which is an accurate measure of the hydrogen flow under all conditions of liquid and gaseous states and is insensitive to bubbles in the flow. Laboratory tests verified theoretical predictions for the system, and showed that liquid cryogenics can be gaged by nucleonics techniques to detect accurately changes of 0.05 lb/ft^3 with a time response of less than 10 milliseconds. (L.C.L.)

12598 DESIGN AND PERFORMANCE EVALUATION OF AIRCRAFT NUCLEONIC FUEL GAGING SYSTEM BY COMPUTER TECHNIQUES. Bradley, C. M.; Dewar, M. A.; Hauck, J. F. (Lockheed Georgia Research Lab., Marietta, Ga.). pp 220-30 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A mathematical model of a nucleonic fuel gaging system which permits system configurations to be evaluated and optimized by computer techniques is described. Previously available computer programs were considered inadequate. Therefore, a specific program was created to deal with the three major factors associated with an aircraft system: variable attitude of the attenuation medium in flight and on the ground, low-energy gamma radiation from fixed isotope sources, and calculation of intensity through relatively short distances in lightweight materials. The validity of the mathematical model is demonstrated by experimentally verifying computed solutions for simple configurations, by computing solutions and testing them in mock-up installation in actual parts of an operational aircraft fuel system, and by flight-testing the computed solutions for an entire aircraft system installation. The computer program deals with the problem in five distinct steps, finally arriving at optimum location for sources and detectors. Results are presented for computed performance and laboratory measurements using a C-141 wing tank under various anticipated flight conditions. (auth)

12599 RADIOISOTOPES FOR LIGHTING. Dooley, H. H.; Mahon, A. F. (American Atomics Corp., Tucson, Ariz.). pp 231-53 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

Recent developments in the use of nuclear radiation in combination with luminescent materials to produce visible light are described. Krypton-85 was chosen as the radiation source, and the theoretical conversion of the beta energy from this source to light energy is evaluated for brightness and intensity. Experimental data for two sizes of ^{85}Kr sources are given. The design and performance of models of radioisotope luminous devices for airport marking and aircraft interior lighting are presented. It is anticipated that self-luminous light sources will be of increasing value in aerospace operations. (L.C.L.)

12600 MOESSBAUER SPECTROSCOPY: APPLICATIONS TO AEROSPACE. DeVoe, J. R.; Spijkerman, J. J. (National Bureau of Standards, Washington, D. C.). pp 254-69 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The use of the Moessbauer effect as an analytical tool whereby an instrument using backscatter radiation detection could determine the chemical structure and even possibly the quantity of compounds of such elements as iron and tin is described. Prior to the development of such a Moessbauer surface analyzer much study will be required on the optimum geometry for each radioisotope used. A decided advantage of the technique is that very little in the way of additional instrumentation needs to be developed beyond that which is available in existing space systems. It is very probable that other elements could be studied. Particularly attractive for a space probe application would be the use of the radioisotopes ^{151}Eu, ^{149}Sm, ^{121}Sb and ^{181}Ta. Some of these present problems in observing the level of effect that would be desirable, but it appears that they could be developed into usable systems. The Moessbauer Effect has been observed by laboratory experiments in about 30 elements. Of even greater importance is the fact that Moessbauer spectroscopy has demonstrated that it is a powerful tool in clarifying the structure of materials and because of this it should be valuable for the development of materials necessary for space applications. (auth)

12601 ELEMENTAL ANALYSIS USING NEUTRON INELASTIC SCATTERING. Waggoner, James A.; Knox, Richard J. (Univ. of California, Livermore). pp 270-91 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The technique of elemental analysis by analysis of the gamma rays resulting from the inelastic scattering of 14 MeV neutrons is described. This method is especially suitable for analysis of the major constituents of bulk samples such as planetary surfaces. Sample size, limits of sensitivity for Fe, Si, O, Mg, Al, Na, K, and Ca, detector resolution, shielding requirements, and geometrical effects are considered. An instrument designed for planetary surface analysis is described as one possible application of this method. This instrument weighs about 15 pounds and includes a pulsed source of 14 MeV neutrons, a gamma ray detector, and a 256 channel pulse height analyzer as well as the necessary electronics. (auth)

12602 EXTRATERRESTRIAL LIFE DETECTION WITH ISOTOPES AND SOME AEROSPACE APPLICATIONS. Levin, Gilbert V. (Hazleton Labs., Inc., Falls Church, Va.). pp 347-57 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A radioisotopic biochemical probe for detecting extraterrestrial life is described. The probe supplies a nutrient medium containing radioactive substrates to a sample of extraterrestrial soil. If any microorganisms are present in the soil, one or more of the labeled compounds may be assimilated, metabolized, and evolved as a gas or gases containing the label. The detection of labeled gas evolved from the soil culture would constitute evidence of life. This tracer method has the important advantages of sensitivity to low levels of metabolic activity, rapidity of response, a counting system which is simple, small and rugged, and the data output can easily be transmitted to earth. The system, using ^{14}C substrates, and its instrumentation have been laboratory and field tested with encouraging results. Other applications of the life detecting probe are foreseen. (L.C.L.)

12603 POODLE RADIOISOTOPE PROPULSION TECHNOLOGY. Jones, I. R.; Austin, G. E. (TRW Systems, Redondo Beach, Calif.). pp 385-408 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

POODLE is a low-thrust propulsion device which utilizes an alpha or beta-emitting radioisotope to heat hydrogen to high temperatures and exhaust velocities. The operating characteristics of POODLE are described and the most promising mission applications are discussed. The status of POODLE is reviewed, including a summary of the feasibility demonstration in which a radioisotope-powered thruster was successfully tested at theoretical specific impulses in the 600 to 700 second range. Resistively heated simulation tests at higher specific impulses are also described. The requirements for developing a flight-design engine capable of delivering a specific impulse of 800 seconds are considered in light of available technology in the areas of fuel forms, materials, nozzle design, and aerospace safety. The key technical areas are summarized along with a description of current progress in POODLE and related programs. (auth)

12604 SNAPOODLE ISOTOPE THRUSTER/ELECTRIC POWER UNIT. Leventhal, E. L. (TRW Systems, Redondo Beach, Calif.). pp 409 26 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

SNAPOODLE is a radioisotope powered device designed to provide a spacecraft with both electric power and thrust. It combines in a single unit a thermoelectric generator and a POODLE type thruster. The SNAPOODLE concept, results of thermal analyses, and calculations of performance capability for a typical SNAPOODLE configuration are described. The potential savings realized by combining the electric power and low thrust propulsion functions in a single SNAPOODLE unit are described. Performance data are given for both the thrust and no-thrust conditions. (auth)

12605 SNAP 19 POWER SYSTEM FOR NIMBUS B. Norin, Marvin P. (Martin Co., Baltimore). pp 427-36 of Radioisotopes for Aerospace. Part 2. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A program to demonstrate radioisotopic power on Nimbus B spacecraft is described. The power supply will provide a minimum of 50 watts of conditioned electrical power. The system energy source consists of two SNAP-19 generators mounted on the spacecraft sensory ring. The generators are fueled with plutonium-238 and utilize thermoelectric energy conversion. Power conditioning is provided by two dc to dc converters housed in a standard Nimbus module. The system is fully instrumented and a second module is used to house a telemetry conditioner. Integration and safety studies are in progress. Electrically heated generators and power conditioners have been built and subjected to developmental environmental tests. Performance testing has been conducted at Martin and at Goddard Space Flight Center. The final phase of the program has been initiated in which complete systems will be tested and integrated with Nimbus B model and flight spacecraft. (auth)

12606 GAMMA RADIATION SOURCE. (to General Electric Co.). British Patent 1,056,565. Jan. 25, 1967. Priority date Feb. 6, 1963, United States.

A radiation source is described which produces γ radiation by a stimulated-emission photon chain reaction. A relatively stable isotope ^{69}Zn is used and is prepared by the neutron irradiation of a ^{68}Zn target. (F.S.)

Materials Testing

Refer also to abstract 12603.

12607 (ORNL-3970, pp 118-24) NONDESTRUCTIVE TEST DEVELOPMENT. McClung, R. W. (Oak Ridge National Lab., Tenn.).

In the continued development of computer calculation of parameters of an induced electromagnetic field, the forces generated in a specimen by eddy currents were calculated and correlated well with experimental results. The impedance of a family of coils under varied operating conditions was also calculated and measured with excellent results. A prototype beat-frequency eddy-current instrument was developed which offers high sensitivity for measuring conductivity variations. The phase sensitivity instrument was further improved for temperature stability, and development of a portable model began. The work on nonbond detection using ultrasonics has been directed toward development of a device for hot-cell examination of fuel tubes of the type used for PM-1 and proposed for HWOCR. Techniques and calibration curves were developed for electrical discharge machining of reference discontinuities for inspection of sheet, plate, and tubing. Techniques are being developed for observing ultrasonic energy in transparent liquids and solids using schlieren and photoelastic effects. The penetrating radiation work has emphasized scintillation detection methods, including use of attenuation to monitor variations in fuel content in vibratorily compacted fuel rods. Fiber optics were superior light pipes for applications in which scintillators and photomultipliers must be separated. Development and evaluation were completed of a monitoring system for assaying ^{235}U in core blanks for fuel plate fabrication. (auth)

12608 (ORNL-TM-1671) PHOTOELASTIC OBSERVATION OF ULTRASONIC WAVES IN A TRANSPARENT PLATE. Snyders, Leon Steyl (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Tennessee Univ., [Knoxville].

The feasibility of using photoelasticity for observation of ultrasonic waves in a semi-infinite transparent plate was studied. A pulsed oscillator was used to drive a piezoelectric transducer, which was in contact with the edge of the model. The stress waves introduced into the plate model were observed with the aid of a polariscope and a light source synchronized with the oscillator pulses. The attenuation coefficient calculated from photoelastic data was 3 times as large as that obtained from strain-gage measurements. It was concluded that the photoelastic method can be very useful for studying attenuation of ultrasonic waves at frequencies up to one megacycle in some transparent materials. (M.C.G.)

12609 (STL-517-0049(Vol.2A)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME IIA. ANALYTICAL PROGRAM FOR CREEP IN AXISYMMETRIC SHELLS (CRASH). Final Report, October 1, 1965-September 30, 1966. Diamant, E. S. (TRW Systems, Redondo Beach, Calif.). Oct. 1966. Contract AT(04-3)-517. 182p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method for calculating the effects of creep in pressurized, axisymmetric, thin-walled shells with end closures is described. The formulation of the pertinent analysis and the associated computer program are discussed. The computer program is described from the user's standpoint and the results of a few illustrative calculations are included. The computer program—code named CRASH for CReep in Axisymmetric SHells—will determine the history of creep effects caused by axisymmetric loads and in the presence of an axisymmetric temperature distribution. The latter may vary arbitrarily along the meridian of the shell, through the thickness, and with time. Certain restrictions discussed more fully in the report permit these variations to be analytically described in polynomial form. The wall thickness may also vary along the meridian and the pressure could vary in time; both of the latter variations are restricted to quadratic analytical formulations. The end closures are elliptical and various shell boundary conditions are included to handle the opposite end of the shell (i.e., at the shell midplane). The analysis was developed for a time hardening type of creep law. The temperature dependence of the creep coefficients was chosen to match available data for W25 Re alloys. (auth)

12610 (SwRI-1228-1-29) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. PART I. CYCLIC PRESSURE TESTS OF FULL-SIZE PRESSURE VESSELS. Technical Summary Report. Pickett, A. G.; Grigory, S. C. (Southwest Research Inst., San Antonio, Tex.). Sept. 1966. Contract AT(11-1)-1228. 152p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work on cyclic pressure tests of full-size pressure vessels is summarized. An historical summary of the program and a detailed presentation of data from experimental stress analyses and fatigue tests are presented. (auth)

12611 (UCRL-50007-66-1, pp 57-60) MATERIALS TESTING. Gaskill, J. R.; Veith, C. R. (California Univ., Livermore. Lawrence Radiation Lab.).

Progress is reported on the testing of coating materials for glove boxes, floors, and ventilation ducts. The coatings were tested for resistance to chemical attack and abrasion. (L.C.L.)

12612 SHORTENED PROCESSING TIME TECHNIQUE FOR COLOR INDUSTRIAL RADIOGRAPHY. Lapinski, Norman P. (Argonne National Lab., Ill.). Mater. Eval., 25: No. 2, 33-5 (Feb. 1967).

By eliminating some of the steps when processing Ektachrome film a desirable color radiograph can be obtained. The length of processing time required to generate a color radiograph by the shortened method is reduced by about a factor of 3. The techniques employed to produce color radiographs as well as a description of the shortened processing technique are reviewed. (auth)

Protective Structures

12613 (JAERI-1110) CONSTRUCTION AND ARRANGEMENT OF MONITORING CAVES. (Japan Atomic Energy Research Inst., Tokyo). Oct. 1966. 76p. (In Japanese). Dep. mn.

The construction of caves to be used for monitoring fuels and structural materials of the Tokai atomic power plant and for testing fuels of JRR-2, JRR-3, and JPDR is described. The design philosophy employed was as follows: the flow chart was prepared for the Tokai power plant; this flow chart was then modified to include the tests for JRR-2, JRR-3, and JPDR; and in the third stage, equipment was selected from the standpoint of the operation. The four caves are used for storage, clean, dirty, and maintenance caves. All equipment testing is done in the clean and dirty caves, according to the kind of tests being performed. A large cave system was adopted for the flow of monitoring tests as well as the dry decontamination system. The caves were tested in operation and showed fairly good results in γ-ray leaks, pressure difference and air flow. (tr-auth)

Radioactive Material Handling

Refer also to abstracts 12559, 12560, 12563, 12564, and 12566–12568.

12614 (KFK-481) JAHRESBERICHT 1965 DER STUDIENGRUPPE FUER TIEFLAGERUNG RADIOAKTIVER ABFAELLE. (1965 Annual Report of the Study Group for Deep Storage of Radioactive Waste). Krause, H.; Ramdohr, H.; Schuchardt, M. (Kernforschungszentrum, Karlsruhe (West Germany)). Aug. 1966. 18p. (In German). Dep. mn.

A brief resume is presented of the studies made on the feasibility of storage of radioactive waste in salt caverns. Manipulation and transportation problems are briefly considered. (J.S.R.)

12615 (ORNL-tr-1445) POT VITRIFICATION STUDY OF THE FLOW OF GLASS. Magne, A. (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn., from report SCCI-61. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $1.04 mf.

In determining the possibilities of control of flow in the process of pot vitrification, tests with nozzles of different diameters were performed in an induction furnace with constant charge and temperature (1200°C) using glass X_{41}. Control of the flow was accomplished with nozzle diameters varying from 18 to 40 mm. The effect of the nozzle length was studied for a nominal diameter of 40 mm. In each test a linear flowrate was measured. The experimental results obtained agree quite well with the conclusions of the theoretical study. These results indicate the possibility of increasing the diameter of the pouring nozzle, the vitrifying pots, and perhaps the elimination of heating of the receiving vessel, which, up to that time, was necessary for obtaining a good coating of glass. (auth)

12616 RECENT DEVELOPMENTS IN THE PROCESSING AND ULTIMATE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE. Belter, Walter G. (Atomic Energy Commission, Washington, D. C.). pp 29-51 of Proc. 16th Ind. Waste Conf., May 2–4, 1961. Purdue Univ., Lafayette, Ind. Lafayette, Purdue Univ., 1962.

Development of ultimate disposal systems for high-level radioactive waste from the chemical reprocessing of irradiated reactor fuel is proceeding along two general approaches, namely, conversion to solids by one of several methods, and direct disposal of liquid and/or solid wastes into specific geologic formations. Calcination techniques being investigated include the fluidized-bed, heated pots, radiant-heat spray column, and a rotary ball kiln. The incorporation of radionuclides in ceramic sponges and the use of phosphites, phosphates, and borates to obtain a more stable, solid product are also being studied. The major effort in the disposal of high-level wastes into geologic formations to date has been the field investigations in salt formations. The exploratory drilling program to determine feasibility of storage in impermeable underground caverns was initiated at the Savannah River Plant. Hydrofracturing work at Oak Ridge National Laboratory is proceeding towards the design of a pilot plant facility with actual Oak Ridge wastes. The fraction of nuclear power costs allowable for waste disposal has not been established, and because of the preliminary status of the development program, no realistic cost estimate for these ultimate disposal methods is now available. However, the cost of storing wastes in tanks of present design on a perpetual care basis has been estimated to lie between 0.1 and 0.15 mill/Kw-hr of electricity produced. This cost approximates only 1 to 2% of the cost of nuclear power in an 8 to 10 mill/Kw-hr economy. Cost estimates for ultimate disposal methods fall within this range, and, if engineering development work substantiates these expectations, waste disposal should not constitute a major obstacle to the development of economic nuclear power. (BBB)

12617 LIMITATION OF THE SURFACE CONTAMINATION FOR HANDLING UNPROTECTED RADIOACTIVE SUBSTANCES. Koenig, L. A. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 12: 555-8(Nov. 1966). (In German).

The order of magnitude of irradiation due to surface contamination is estimated with regard to the different kinds of exposure. Standard values for the limitation of contamination may be deduced from these evaluations. The inhalation risk following the resuspension in air of loose contamination (bad ventilation being presumed) leads to the most limiting conditions. The evaluations practically lead to the order of magnitude of those standard values, which are already used at some places. The safety of persons handling uncovered radioactive substances depends decisively on the precautionary measures taken, e.g., protective clothing and respiratory protection. Therefore, the importance of limiting contamination must not be underestimated. The introduction of new standard values is not considered to be urgent. If they are to be introduced, however, reflections show that it would be sensible to fix these standard values for the nuclides concerned as proportional to the maximum permissible concentrations for respiratory air. (auth)

12618 DECONTAMINATION OF RADIOACTIVE WASTE WATERS BY SORPTION ON MAGNETIC MATERIALS. Starke, K.; Quecke, Ch. (Philipps-Univ., Marburg, Ger.). Atompraxis, 12: 503-4; 507-8(Oct. 1966). (In German).

Decontamination by adsorption often involves the movement of a large volume of liquid during the filtration or centrifugation. Lifting the less bulky adsorbent directly from waste water would allow the liquid to remain in the container and the process to be repeated easily. The possibility of using magnetic adsorbents was investigated. Radioisotopes of strontium, cobalt and cesium were adsorbed on artificial magnetite and on two commercial products containing magnetic gamma-iron oxide. Improvements of the method are suggested. (auth)

12619 METHOD OF DISPOSING OF WASTE MATERIALS PARTICULARLY RADIOACTIVE WASTE. (to Halliburton Co.). British Patent 1,054,740. Jan. 11, 1967. Priority date Dec. 29, 1964, United States.

A method is described for the subterranean disposal of radioactive waste. The method consists of producing a wellbore having a casing which penetrates a fractured earth formation. A low-viscosity slurry containing the waste material, water, hydraulic cement, clays, an agent which reacts chemically with the cement retarding its setting. The slurry is injected into the fracture and allowed to set which confines the radioactive waste to the formation. (F.S.)

Vacuum Engineering

12620 ADSORPTION OF PUMP FLUIDS ON CLEAN METAL SURFACES. Doering, G.; Marx, G.; Sauerbrey, G. (Technische Univ., Berlin). Vakuum-Tech., 15: 245-9(Dec. 1966). (In German).

The adsorption of vapor from diffusion pump fluids on clean nickel surfaces was investigated by means of an oscillating quartz crystal. On clean surfaces the weight of the adsorption layer amounted to 8 to 9×10^{-8} g/cm^2 which corresponds to a layer thickness of 8 to 9 Å for a density of 1 g/cm^3. This corresponds to a monomolecular layer for molecular weights of approximately 500. The adsorption test was performed in ultrahigh vacuum (10^{-10} torr), the adsorbant was Siliconoil DC 704, and the saturation point was reached after 12 hours. After evacuation of the equipment ($p = 10^{-7}$ torr) the adsorption curve had a pure exponential

form. The saturation point, again for a monolayer, was reached at a time constant of never more than 50 to 70 minutes. (auth)

12621 TURBOMOLECULAR PUMPS. PART II. Becker, W. (Pfeiffer Hochvakuumtechnik GmbH, Wetzlar, Ger.). Vakuum-Tech., 15: 254-60(Dec. 1966). (In German).

The development and theory of the turbomolecular pump is discussed. With this theory the experimental results are explained. The relation between pressure ratio and pumping speed is shown for different gases. The pumping speed for all gases is approximately constant, while the compression ratio depends in a high degree on the kind of gas pumped. The logarithm of the compression ratio increases with the square root of the molecular weight, thus explaining the high blocking efficiency of the pump for oil vapors. A short summary of the applications of turbomolecular pumps is given. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 12306, 12373, 12838, and 13973.

12622 (AD–638725) A MONTE CARLO CALCULATION TO SIMULATE DETECTOR RESPONSE TO UNDERWATER GAMMA RAYS. Madigosky, Susan W.; Simons, Donald G. (Naval Ordnance Lab., White Oak, Md.). July 14, 1966. Contract AT-(49-7)-2430. 70p. (NOLTR–66–140). CFSTI $3.00 cy, $0.65 mn.

The response function of a scintillation detector surrounded by a monoenergetic gamma-ray source which is uniformly dispersed in an infinite volume of water was calculated. The method of calculation is that of random sampling (Monte Carlo) and is programmed for the IBM 7090 computer. Rather than starting the sampling by taking gamma-ray sources at random throughout the volume of water the response is determined for a weighted set of secondary gamma-ray sources taken to be on the surface of the detector system. The spectrum of secondary energies chosen is taken to be the equilibrium flux distribution which is obtained in an infinite volume of water in which there is no detector. The detector response is determined by a superposition of the weighted secondary sources. Detector response has been obtained for gamma-ray sources from Cr51, Cs137, K40, Na24, and Ce144. The calculated response for these sources agrees quite well with the measured response in shape but not in magnitude. Here, it is found that the artificial spectra have an amplitude which is approximately 1.6 times the measured spectra. This difference appears to be mainly due to two sources: the difference in geometry between the actual spectrometer and the spectrometer used for the calculation and the approximation in which the distribution of secondary source neglects the presence of the detector. (auth)

12623 (AD–640318) MOESSBAUER-EFFECT SPECTROSCOPY. Temperley, A. A. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Oct. 1966. 36p. (NDL-TM–33). CFSTI $3.00 cy, $0.65 mn.

Mössbauer-effect spectroscopy is discussed with emphasis on spectrometer design. Construction of a Mössbauer-effect spectrometer using a loudspeaker as the velocity transducer, capable of operation with either constant velocities or with constant accelerations, is described. Resonance experiments with the 14.4-keV Mössbauer-effect gamma ray from $^{57}Co(^{57m}Fe)$ are used to describe the performance of the spectrometer. (auth)

12624 (AD–641654) DEVELOPMENT OF A HIGH-INTENSITY SOLID-STATE GAMMA-RAY DOSIMETER SYSTEM. Final Technical Report. Fletcher, C. L. (General Dynamics/Fort Worth, Tex.). July 18, 1966. Contract N228(62479)67947. 63p. (USNRDL-TRC–53). CFSTI $3.00 cy, $0.65 mn.

Design, construction, and testing of an integrating gamma-ray dosimeter for high dose rates are discussed. The sensor is a silicon surface-barrier detector operating as a current device. The detector output current is integrated on a capacitor. When the voltage on the capacitor rises to a predetermined level corresponding to 10 rad-equivalent-air of gamma-ray dose, the capacitor is discharged and the instrument produces an output pulse to signal the event. The number of output pulses indicates integrated dose, and the pulse repetition rate indicates dose rate. The detector proper is cooled with a thermoelectric cooler to minimize and stabilize leakage current. The instrument is designed for operation in the dose-rate range of 10 to 100,000 rad-equivalent-air per second. The detector is constructed to make it function as a Bragg-Gray device over the gamma-ray energy range of 80 kev to 12 Mev. The detector is reasonably isotropic; cumulative errors due to all causes are less than plus or minus 30%. The electronics are insensitive to gamma-radiation transients for dose rates as high as 1,000,000 rad per second. Results of tests with radioactive sources, a fast-burst reactor, and bremsstrahlung pulses are given. (auth)

12625 (BMwF-FBK–66–31) DER UEBERGANG ELEKTRONENLAWINE-PLASMAKANAL, UNTERSUCHT MIT BILDVERSTAERKER UND WISCHVERSCHLUSS. (Avalanche-to-Streamer Transition Recorded with Image Intensifier Streak Camera). Wagner, K. H. (Hamburg Univ. (West Germany). Institut fuer Angewandte Physik). Oct. 1966. 24p. (In German). Dep. mn.

Image converter streak shutter (RCA 4449) and image intensifier (WX 4701) make possible continuous photographic recording of the electron-avalanche-to-streamer transition by means of the initially weak radiation emitted by the discharge itself. When the gaseous amplification is approx. 10^8 the streamer will start and with reference to a coordinate-system moving with the electron drift velocity, will run about equally fast towards anode and cathode. Velocity measurements suggest photoionization and gaseous amplification in the eigen-space charge field to be the determining effects. Secondary avalanches from the cathode may accelerate streamers in later stages. Quantitative results make possible the determination of time lags in spark development for various conditions. (auth)

12626 (BNL–10864) PROBLEMS USING TWO-DIMENSIONAL PULSE-HEIGHT ANALYSIS. Alburger, David E. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT-30-2-GEN-16. 42p. (CONF-670103–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Low Energy Nuclear Physics, Dacca, East Pakistan.

Recent research at Brookhaven making use of two-dimensional pulse-height analysis is reviewed. Particle-gamma, gamma-gamma, and particle-particle coincidence effects are discussed, and examples are given of research problems carried out at both the 3.5-MeV Van de Graaff and the 60-inch cyclotron. The computer techniques of data simulation, light-pen applications, and associative-memory storage are mentioned in connection with particle-particle coincidence analysis. (auth)

12627 (BNL-10994) A FEW REMARKS ABOUT THE CRYSTAL SIZE AT DUMOND TYPE SPECTROMETERS FOR (n,γ)-MEASUREMENTS. Schult, O. W. B. (Technische Hochschule, Munich (West Germany). Brookhaven National Lab., Upton, N. Y.). [nd.] Contract AT-30-2-GEN-16. 7p. (CONF-661113-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

Simple beam geometrical considerations show that the maximum sensitivity for the detection of weak (n,γ)-transitions at DuMond type curved crystal spectrometers is obtained if the crystal dimensions are less than the diameter of the through hole close to the reactor core. The dependence of the sensitivity on the crystal height reveals a broad maximum from which it can be concluded that crystals having a height of only half of the diameter of the liner will yield good sensitivity. The crystal breadth should be chosen according to the defocussing properties of the curved crystal in the energy region of maximum interest: at high energies, a little less than the diameter of the beam tube and at very low energies considerably smaller if the liner is wide. The considerations are based on a radius of curvature of 8m for the bent crystal. (auth)

12628 (CLOR–57/D) BETA DOSE RATE MEASUREMENT WITH SILICON COUNTER. Roman, J.; Sawicka, B. (Centralne Laboratorium Ochrony Radiologiczne), Warsaw (Poland)). 1966. 11p. Dep.

The use of silicon surface-barrier detector, as an extrapolation parallel plate ionization chamber, in measuring of beta radiation dose rate was investigated. The detector response was compared to the surface absorbed dose rate in tissue, measured with an extrapolation air ionization chamber. It was found that the correlation is sufficiently good and that the extrapolation silicon counter is suitable for the use under laboratory, as well as field conditions. The beta radiation dose rate range from few milirads to few hundred rads can be covered. (auth)

12629 (EGG–1183-2100) LINAC MEASUREMENTS OF THE FAST NEUTRON RESPONSE OF ORGANIC SCINTILLATORS, Number S-356-R. Yates, E.; Crandall, D.; Kirkbride, J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Nov. 1966. Contract W-7405-eng-48. 14p. (UCRL–13263; CONF-661020–16). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Lawrence Radiation Lab., Livermore, Calif.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

The 20-MeV linac at EG&G, Santa Barbara, produces fast neutrons up to 11 MeV by the photoneutron reaction in a beryllium target. With a 10-nanosecond linac burst and a 25-meter evacuated flight path, neutron energy resolutions ranging from 7 percent at 10 MeV to 1.4 percent at 0.4 MeV are obtained. A plastic scintillator identical to that designed by Batchelor was placed at the end of the flight path, and its scintillation output was placed in coincidence with narrow time windows. These windows could be varied in width and position with respect to the linac burst. The scintillations passing through a window were the response of the detector to neutrons of a narrow band of energies. By scanning the window in time, the neutron pulse-height response of the detector was measured for neutrons from 1 to 8 MeV. In a sepa-

rate experiment the neutron detection efficiency of a 6-inch cube of MEL 150 C plastic scintillator was derived by comparison with Batchelor's detector; that is, the same time-of-flight neutron spectrum was measured by both detectors. This is a new and convenient application of the linac time-of-flight technique for measuring the neutron response and efficiencies of organic scintillators. (auth)

12630 (KFK-411) DAS GROSSFLAECHENPROPORTIONAL-ZAEHLROHR. (The Large-Surface Proportional Counter). Kiefer, Hans (Kernforschungszentrum, Karlsruhe (West Germany). Schule fuer Kerntechnik). Mar. 1966. 117p. (In German). Dep. mn.

Thesis.

The development of large surface proportional counters for activity determination of low specific radioactivities, for the energy determination of measured radiation, and for dose determination is outlined. The characteristics and properties of the detectors designed for these purposes are given. The use of large-surface proportional counters in monitoring is discussed. The use of these counters in the continuous measurement of α/β ratios of the radioactivity of air dust, measurement of α-particle x-ray coincidences for specific ^{239}Pu monitoring, and continuous tritium monitoring in air and water is described. (J.S.R.)

12631 (N-66-24954) [FUNDAMENTAL STUDIES ON SEMICONDUCTOR RADIATION DETECTORS]. Annual Status Report No. 2, March 1, 1965-February 28, 1966. Casper, Karl J. (Western Reserve Univ., Cleveland, Ohio). [1966]. 53p. (NASA-CR-74766). CFSTI $3.00 cy, $0.65 mn.

A summary is presented on research progress on studies of the response functions of lithium drifted silicon detectors to monoenergetic electrons, a preliminary investigation of the temperature dependence of the resolution of lithium drifted silicon detectors, fabrication of large volume lithium drifted silicon detectors, studies of the internal Compton effect using a superconducting magnet beta ray spectrometer, ohmic contacts to silicon detectors, and studies of high Z semiconductors for radiation detectors. (STAR)

12632 (N-66-25577) LTV BETA-GAMMA SPECTROMETER, MODEL BG-1. Final Report. Chappell, N. E.; Farmer, B. J. (LTV Aerospace Corp., Dallas, Tex.). Aug. 1965. Contract NAS9-4013. 41p. (NASA-CR-65354). CFSTI $3.00 cy, $0.65 mn.

A beta-gamma spectrometer in space prototype configuration was built to measure simultaneously the spectra of electrons and bremsstrahlung, at the same time eliminating background cosmic radiation. These functions are accomplished through the use of a complex scintillation crystal assembly composed of two phosphors with different phosphorescent decay times. It is noted that, since the radiation received by an astronaut may result from either bremsstrahlung or direct electron penetration through the spacecraft walls, such a device offers several advantages over a combination of devices necessary to perform the same function in space. It is further noted that this concept has also proven useful in laboratory measurements of electrons scattered by foils, where bremsstrahlung would normally produce exceptionally high backgrounds. The output of the apparatus is in two separate channels of linear pulse height information compatible with a multichannel pulse height analyzer. In conjunction with an appropriate selective storage unit, both beta and gamma spectra may be stored in separate sections of the analyzer memory. (auth)

12633 (N-66-32698) STUDY AND DEVELOPMENT OF THE STERILIZABLE GEIGER-MULLER TUBE. Final Report. Weinberg, G. R. (Eon Crop., Brooklyn, N. Y.). Apr. 1966. Contracts NAS7-100; JPL-951240. 44p. (NASA-CR-76644). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

During the development of the sterilizable Geiger-Müller tubes, it was noticed that a number of the thin mica end window tubes exhibited a downward change in starting voltage. This occurred most often during the dry heat sterilization cycles. The drop in starting voltage was believed attributable to a slow chemical reaction between the chlorine content of the filling gas mixture and the base material of the cathode. It was further believed that by cladding the cathode surfaces with a protective coating of resistant metal this difficulty could be eliminated. A thorough investigation of plating and processing techniques was made in order to obtain clad cathode surfaces which were both mechanically and microscopically perfect and which would provide protection of the cathode base material. (auth)

12634 (NP-16409) ESTUDIO DEL TIEMPO MUERTO DE ALGUNOS DETECTORES NUCLEARES MEDIANTE UN METODO DE MONTE CARLO. (Monte Carlo Method for Computing the Dead Time of Nuclear Detectors). Rodarte Ramon, Ubaldo Sergio (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1965. 37p. (In Spanish). Dep. mn.

Thesis.

From a model for the functioning of G-M detectors, an empirical formula is obtained which relates the emission velocity of a source with the counting velocity of the detector, the resolution time, and the dead time/recovery time ratio. Two practical methods, one of which is graphic and the second of which uses an approximation of the proposed empirical formula, are outlined with which the values of the counter parameters can be determined. (tr-auth)

12635 (NP-16449) UTILISATION DU CUIVRE COMME INTEGRATEUR DE NEUTRONS RAPIDES. (Use of Copper as an Integrator of Fast Neutrons). Lloret, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 16, 1965. 27p. (In French). Dep. mn.

The progress made in the study of the use of Cu as a fast neutron integrator is reported. On the basis of the first progress report, a more normal analysis relating the activity to the flux was formulated. Cu was calibrated in SILOE. The problems posed by the suppression of the Cd filter were examined. The results showed that the irradiation of Cu without a screen poses still unresolved problems, and the use of a Gd case is recommended. (J.S.R.)

12636 (NP-16489) UTILISATION DE DIODES DU TYPE SEMI-CONDUCTEUR COMME DETECTEURS DE NEUTRONS. (Use of Semiconductor Diodes as Neutron Detectors). Fabre, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1965. 16p. (In French). Dep. mn.

The advantages and disadvantages of the use of semiconductor diodes as neutron detectors were studied. The basic characteristics of diode detectors are outlined. The results show that the diodes have the following advantages. They are light and compact and can be made robust. The associated circuits occupy a small space. There is a significant counting rate with a low polarization voltage. Energy discrimination can be made and the diodes do not undergo significant damage at high counting rates. They have the disadvantage of having a low delivered amplitude so that amplification is necessary and a small sensitive zone. (J.S.R.)

12637 (ORO-2504-99) BRAVE: UNIVERSITY OF MARYLAND TVGP PREPROCESSOR. Technical Report No. 648. Glasser, R. G. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1966. Contract AT(40-1)-2509. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer program (BRAVE), which is used to prepare the output from the University of Maryland's measuring machines for TVGP-the three view geometry program, is described. (B.G.D.)

12638 (ORO-2504-100 and Suppl.) TVGP-SQUAW (MD VERSION) OPERATIONAL INFORMATION. Technical Report No. 649. Day, T. B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1966. Contract AT(40-1)-2504. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The various operational aspects of TVGP and SQUAW computer programs are described. Both programs are heavily commented, and most of the information presented is just selections of such comment cards. (B.G.D.)

12639 (SAN-549-2) RESEARCH AND DEVELOPMENT ON SINGLE-CRYSTAL HIGH RESISTIVITY CADMIUM TELLURIDE FOR USE AS A GAMMA RAY SPECTROMETER. Annual Report. Baily, N. A. (Hughes Research Labs., Malibu, Calif.). Sept. 1966. Contract AT(04-3)-549. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was made on the use of single-crystal high resistivity cadmium telluride as a gamma ray spectrometer. Topics discussed are material parameters, material growth, fabrication techniques and test results including diode evaluation, particle response and response to beta and gamma rays. (B.G.D.)

12640 (UCRL-50007-66-1) HAZARDS CONTROL PROGRESS REPORT NO. 25, APRIL-AUGUST 1966. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An abstract was prepared for each of the fifteen papers presented. (B.G.D.)

For abstracts of individual papers see: 12530, 12531, 12551-12554, 12611, 12641-12643, 12687-12690, and 12754.

12641 (UCRL-50007-66-1, pp 8-10) DETECTION OF NEUTRON CAPTURE GAMMA RAYS PRODUCED IN SEA WATER. Schmidt, C. T.; Beard, E. L.; Koch, J. J. (California Univ., Livermore. Lawrence Radiation Lab.).

An experimental evaluation is given of radiation survey capabilities that could be used in situations such as the recent lost bomb incident off the Spanish coast. The experimental results of capture gamma production in sea water using scintillation spectrometric techniques are reported. (B.G.D.)

12642 (UCRL-50007-66-1, pp 15-21) SOLID STATE BETA SPECTROMETER. Prevo, C. T.; Cate, J. L. (California Univ., Livermore. Lawrence Radiation Lab.).

The use of Li-drifted silicon detectors as a means of measuring β spectra is investigated. A simple analytical method that allows fairly rapid identification of Emax (with accuracies of circa ±5%) and the resolution of up to 3 or 5 superimposed spectra is described. (B.G.D.)

12643 (UCRL-50007-66-1, pp 22-4) ABSOLUTE THERMAL NEUTRON FLUXMETER. Prevo, C. T.; Cate, J. L.; Montan, D. N. (California Univ., Livermore. Lawrence Radiation Lab.).

The design, calibration, and use of a neutron telescope (absolute thermal neutron fluxmeter) are reported. The telescope consists of a $^{10}BF_3$ proportional counter mounted in a pair of telescoping aluminum tubes lined with 0.032-in. cadmium sheeting. The pulses from the detector go via a solid-state, charge-sensitive preamplifier into a scaler-timer. (B.G.D.)

12644 (USNRDL-TR-1099) A SEARCH FOR A FAST DECAY COMPONENT IN NaI(Tl). AN EVALUATION OF THE RCA 8575 PHOTOMULTIPLIER TUBE. Hurley, J. P.; DaGragnano, V. L.; Mathiesen, J. M. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 2, 1966. 22p.

The general performance of selected RCA 8575 photomultiplier tube-NaI(Tl) scintillator combinations was examined. The measurements were made with NaI(Tl) crystals packaged with both glass and quartz windows. The results of the study show that the 8575 is fast, quiet, and shows virtually no internal interaction effects. In addition it was found that the increased light transmission capabilities of the quartz window produced no measurable changes in the measured resolving times. (auth)

12645 (AD-643601) NUCLEAR DETECTORS AND THEIR USES. Wang, Chu-hsian. Translation of Ho Wu Li T'an Ts'e Ch'i I Chi Ch'i Ying Yung, 1964. 774p. (FTD-TT-65-552). CFSTI $3.00 cy, $0.65 mn.

An introduction to detection techniques in nuclear physics is presented. It is divided into four parts: the fundamentals of nucleonic experiments, various types of detectors, synchronous application of detectors, and reduction of experimental data. (B.G.D.)

12646 (ANL-Trans-417) THE FLUORESCENCE FADING OF SOME INORGANIC SCINTILLATORS AT THE EXCITATION BY α-PARTICLES, PROTONS OR γ-RAYS (ELECTRONS). Neuert, H. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 239-59 of Festkoerperprobleme, Volume I, F. R. Vieweg and Sohn, Brunswick, 1962. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.95 mf.

Experimental results are presented on the fluorescence fading of ten inorganic scintillators, in the range of approximately 10 nsec to some μsec, excited by alpha particles, protons, and gamma radiation. (B.G.D.)

12647 WHOLE-BODY COUNTER. Kiefer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiologe, 4: 362-4(Nov. 1964). (In German).

The principles of the construction, calibration, and limits of detection of the whole-body counter are discussed and illustrated with results obtained from such an installation. (TSS)

12648 MEASURING THE DOSE RATES OF NATURAL ENVIRONMENTAL RADIATION BY GAMMA-RAY-SPECTROMETRY. Keil, R. A.; Rajewsky, B. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Atompraxis, 12: 579-81(Nov. 1966). (In German).

The importance of measurements concerning dose rates from natural environmental radiation is pointed out. In particular, the separation by x-ray spectrometry of radiation due to nuclides occurring naturally and in fallout is described. Investigations of natural radiation environment in areas with exceptional radiation levels are very important in radiation protection and epidemiological studies. An arrangement for gamma spectrometry, installed in the rear compartment of a car is described and determination of exposure rates based on pulse height spectra is explained. (auth)

12649 A SMALL, LIGHTWEIGHT PRECORDIAL COUNTER FOR DETERMINATION OF CARDIAC OUTPUT. Gorten, Ralph J. (Veterans Administration Hospital, Durham, N. C.). J. Appl. Physiol., 20: 1365-6(Nov. 1965).

A lightweight (0.5 kg) precordial detector was constructed for use with iodinated (^{125}I) albumin. It is much smaller than a conventional detector and can be firmly strapped to a subject's chest while he performs bicycle or treadmill exercise. Such a compact scintillation detector that can be attached to the anterior chest improved the isotope-precordial counting technique for measurements of cardiac output during exercise. An L-shaped housing was constructed out of aluminum alloy for a detector that contains a thin beryllium window, a 2 × 18 mm thallium-activated NaI-wafer scintillation crystal that is 98% efficient for ^{125}I radiation, a transistorized preamplifier, and a cable attachment. The instrument is used with a conventional count-rate meter and a linear chart recorder. In this manner useful indicator-dilution curves could be obtained without arterial puncture at light-to-heavy levels of bicycle ergometer or treadmill exercise. The use of a thin crystal and the omission of lead shielding and collimation of the detector is possible with a soft-energy γ-emitting indicator of blood flow such as ^{125}I-albumin. (BBB)

12650 ACCURATE DETECTION OF NONSTATIONARY CONCENTRATIONS OF RADIOACTIVE GASES IN FLOW COUNTERS. Pankov, A. M.; Ruban, V. A. Radiokhimiya, 8: 232-40(1966). (In Russian).

A detailed analytical investigation of the forms and characteristics of the distortion of the Gaussian peak during detection in slow chambers was reported. On the basis of the analytical study a method was proposed and experimentally tested for the restoration of the true parameters of the displaced chromatographic peak of ^{85}Kr and ^{133}Xe. A method for the accurate registration of random distribution of concentrations (dynamic and kinetic curves) in detectors of the relaxation type based on the reverse transformation of signals by means of miniature RC chains was indicated. (tr-auth)

12651 PROPAGATION VELOCITY OF DISCHARGE IN SELF-QUENCHING COUNTER. Lauterjung, K. H.; Sliwinski, Peter (Univ., Cologne). Z. Phys., 199: 1-7(1967). (In German).

The velocity v of the propagation of discharge along the anode of a self-quenching G-M counter is a function of total pressure P, pressure of the quenching gas P_D, radius of the cathode r_a and of the anode r_i and V_β the difference between working and starting potential. For the mixtures argon-methylal, argon-alcohol, and helium-alcohol $v = v_0 \cdot \exp[k \cdot (V_\beta/V_e)^{1/2}]$ with v_0 the velocity at the starting potential V_e $v_0 = (a + b \cdot P_D/P) \cdot V_n^{1/2} \cdot \exp[(c - d \cdot P_D/P) \cdot V_n^{-1/2}]$ and $V_n = V_e \cdot (\ln r_a/r_i)^{-1}$. k, a, b, c and d are characteristical constants of the filling gas. (auth)

12652 ION REGISTRATION PROBABILITY OF VAPOR COUNTERS. Berresheim, K. (Univ., Cologne). Z. Phys., 199: 88-93(1967). (In German).

Geiger counters with low filling pressure can be used for the registration of ions. The probability of registration of a counter filled with iodine vapor was studied for rare gas ions and alkali ions in the energy range of 0.3 to 3.0 keV. All ions used were found to be registered at least with a probability of 90%, if they had an energy of 1.8 keV. (auth)

12653 FOIL INTERCALIBRATION FACTORS IN NEUTRON FLUX MEASUREMENTS. Fava, L.; Sangiust, V. (CESNEF, Milan). Nucl. Instrum. Methods, 48: 355-6(1967).

Foil intercalibration factors in neutron flux measurements are determined, together with relative flux values, as a result of different irradiations with rotation of the irradiation positions of the different foils. (auth)

12654 MAGNETIC PARTICLE ANALYZER WITH ZERO ENERGY DISPERSION. Elbek, B. (Univ., Copenhagen). Nucl. Instrum. Methods, 48: 353-4(1967).

A magnetic analyzer with zero energy dispersion is described which allows particles emitted from a point source to be focused into an image which has a position independent of particle energy and angle of emission. A solid state detector placed at the focal point will therefore record the fall energy spectrum. (B.G.D.)

12655 IMPROVEMENT OF ALPHA-PARTICLE RESOLUTION OF SILICON SURFACE-BARRIER DETECTORS BY COOLING. Engelkemeir, D. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 48: 335-7(1967).

It is shown that the alpha-particle resolution of surface-barrier Si detectors may be significantly improved by cooling to about -30°C. This improvement is due principally to the reduction of leakage currents which contribute to preamplifier noise. Cooled detectors of 1 cm^2 area typically give line widths of 13-15 keV fwhm for 5.5 MeV alpha particles. (auth)

12656 MOUNTING PROCEDURE FOR Ge(Li) DETECTORS. Adams, F. (Ghent Univ.). Nucl. Instrum. Methods, 48: 338-40 (1967).

A method for mounting lithium-drifted germanium detectors is described. The method consists of etching in a 3-1 mixture HNO_3 70%-HF 50% at 80°C immediately after the clean-up drift, quenching in bidistilled water, application of Ga-In contacts, and

immersion in 30% H_2O_2 for 30 min. The detector is then dried on filter paper in a clean atmosphere of 48–50% relative humidity, installed in a cryostat, and brought under a vacuum. (B.G.D.)

12657 NOTE ON THE MICROWAVE SPARK CHAMBER. Doviak, R. J.; Lombardini, P. P.; Goldhirsh, J. (Univ. of Pennsylvania, Philadelphia). Nucl. Instrum. Methods, 48: 344(1967).

A brief discussion is presented on the operation of an isotropic spark chamber. A technique to observe particle traces is also presented. (B.G.D.)

12658 DIRECT METHOD OF MEASUREMENT OF CHARGE PER PULSE IN ORGANIC VAPOR-QUENCHED GM COUNTERS. Akutsu, J. (Inst. of Physical and Chemical Research, Tokyo); Kanno, K. Nucl. Instrum. Methods, 48: 347-8(1967).

A new method of measuring the charge per pulse generated in a Geiger–Mueller counter from a single voltage pulse pattern observed by a synchroscope is described. (B.G.D.)

12659 TIME MODE TYPE MOESSBAUER SPECTROMETER. Michalski, M.; Piekoszewski, J.; Sawicki, A. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods, 48: 349-50(1967).

An extension of the time analyzer mode of a velocity spectrometer with self-synchronized (by the analyzer) linear movement of the source or absorber for Moessbauer experiments is discussed. This method, with the use of 256-channel time analyzer in time mode operation provides the resolving time which could be secured only with the use of 1024-channel analyzer in conventional mode. (B.G.D.)

12660 SPECTROMETRY OF LOW-ENERGY γ- AND X-RAYS WITH Ge(Li) DETECTORS. Drexler, G.; Perzl, F. (Gesellschaft fuer Strahlenforschung mbH, Munich). Nucl. Instrum. Methods, 48: 332-4(1967).

The efficiency of lithium-drifted germanium detectors for gamma-ray and x-ray spectrometry is discussed. (B.G.D.)

12661 OPERATION OF A SINGLE WEDGE GAP BETA RAY SPECTROMETER AND AN ON-LINE COMPUTER FOR THE MEASUREMENT OF SHORT LIVED BETA SPECTRA. Armini, A. J.; Polichar, R. M.; Sunier, J. W. (Univ. of California, Los Angeles). Contract Nonr 233-(44). Nucl. Instrum. Methods, 48: 309-14(1967).

A system designed to measure the beta spectra of short lived isotopes with energies up to 15 MeV is discussed. It makes use of the focusing properties of a single wedge gap spectrometer and of the data acquisition and processing facility of an on-line SDS 925 computer. The separation of the data in their component half-lives and their normalization are discussed. An application to the beta decay of ^{24}Al and ^{24m}Al is presented. (auth)

12662 STUDY OF HIGH VOLTAGE PULSE GENERATOR FOR APPLICATION IN A SPARK CHAMBER. Metzger, G.; Riedinger, M.; Schmitt, F.; Sutter, G.; Chevallier, P. (Institut de Recherches Nucleaires, Strasbourg. Univ., Mulhouse, France). Nucl. Instrum. Methods, 48: 315-20(1967). (In French).

A spark gap high voltage pulser was constructed for use with spark chambers. Its efficiency and delay was studied for various electrode spacings and pressures of nitrogen, argon, helium and neon. Delays can be obtained below 10 nsec. A theoretical analysis of the high voltage pulse of the spark gap is also given. (auth)

12663 OPTIMUM DISTRIBUTION OF COUNTER TIME. Goldin, A. S. (Northeastern Radiological Health Lab., Winchester, Mass.). Nucl. Instrum. Methods, 48: 321-2(1967).

The statistical basis for optimum distribution of counting time between sample and background was investigated for the case where several samples are counted per day. The minimum statistical counting error is obtained when the background counting time is increased by a weighting factor equal to the square root of the number of samples counted daily. This weighting factor is applied in addition to the usual factor based on ratio of sample counting rate to background counting rate. (auth)

12664 USE OF A DIFFERENTIAL IONIZATION CHAMBER IN THE STUDY OF LONG HALF-LIVES. Walker, D. A.; Easterday, H. T. (Oregon State Univ., Corvallis). Contract AT(45-1)-1062. Nucl. Instrum. Methods, 48: 277-81(1967). (RLO-1062-666).

The principle of the differential ionization chamber is discussed. The system used for the measurement of the half-lives of ^{46}Sc, ^{182}Ta, and ^{144}Ce is described in detail. Results: ^{46}Sc, $T_{\frac{1}{2}} = 84.3 \pm 0.4$ d; ^{182}Ta, $T_{\frac{1}{2}} = 117.3 \pm 1.0$ d; ^{144}Ce, $T_{\frac{1}{2}} = 287.5 \pm 3.5$ d. The errors represent the standard error of the mean. A table of previous measurements is included. (auth)

12665 A Ge(Li) SPECTROMETER FOR STUDYING NEUTRON CAPTURE GAMMA RAYS. Orphan, V. J.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). Contract AF19(628)-5551. Nucl. Instrum. Methods, 48: 282-95(1967).

A gamma-ray spectrometer, using a 30 cm^3 coaxial Ge(Li) detector, which can be operated as a pair spectrometer at high energies and in the Compton suppression mode at low energies provides an effective means of obtaining thermal neutron capture gamma spectra over nearly the entire capture gamma energy range. The energy resolution (fwhm) of the spectrometer is approximately 0.5% at 1 MeV and 0.1% at 7 MeV. Capture gamma-ray energies can be determined to an accuracy of about 1 keV. The relatively high efficiency of this spectrometer allows the use of an external neutron beam geometry, which simplifies sample changing. Using a 4096 channel pulse height analyzer, the capture gamma spectrum of an element may be obtained in about one day. Low cross section (order of 0.1 b) elements with many weak intensity gammas may be studied. Over 100 gamma rays were identified in the spectrum of one such element, Zr. Spectra of Ti and Zr are presented to illustrate the performance of the spectrometer. (auth)

12666 PULSE SHAPE DISCRIMINATION CIRCUIT FOR LITHIUM-DRIFTED GERMANIUM DIODES. Tamm, U.; Michaelis, W.; Coussieu, P. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 48: 301-5(1967).

A pulse-shape discrimination circuit was developed which is sensitive to a slow time-constant component in the charge carrier collection of lithium-drifted germanium detectors. Preamplifier output pulses containing such a component are rejected. By this method the spectrum shapes can be improved considerably. In high-energy gamma-ray spectra the background under the peaks is reduced by a factor of up to 3. The resolution of the spectra is not affected. The attenuation of the peaks is certainly less than 10%. (auth)

12667 ELECTRON CAPTURE IN BF_3-PROPORTIONAL COUNTERS. Froehlich, H. (Friedrich-Schiller Univ., Jena, Ger.); Brinckmann, H. F. Nucl. Instrum. Methods, 48: 236-44(1967). (In German).

A new method for determination of electron capture in BF_3 proportional counters is described. From the measured impulse distribution in dependence of the place of primary ionization, the factor of electron capture c and the capture cross section for electrons σ_{el} is calculated. It can be shown, that electron capture in BF_3 causes a reduction of pulse height. The dependence of σ_{el} from the gas amplification A is given for BF_3 pressures of P = 30, 60 and 76 cmHg. (auth)

12668 RESPONSE OF A LIQUID IONIZATION CHAMBER TO GAMMA RADIATION AND TO HIGH-ENERGY NEUTRONS AND PROTONS. Charalambus, S. (CERN, Geneva). Nucl. Instrum. Methods, 48: 181-92(1967).

The ionization current produced in a chamber filled with dielectric liquid, e.g. hexane, was studied. The chamber was exposed to gamma rays and to high-energy proton and neutron beams from the CERN accelerators. The experimental results obtained are discussed; it is shown in particular that the quality factor of an unknown radiation field may be estimated from measurements made with a liquid ionization chamber. (auth)

12669 HIGH SENSITIVITY SCINTILLATION SPECTROMETER FOR BACKGROUND NEUTRONS. Doke, T.; Adachi, M.; Kubota, S.; Tsukuda, M.; Tajima, E. (Rikkyo Univ., Tokyo). Nucl. Instrum. Methods, 48: 245-53(1967).

An omnidirectional high sensitivity neutron spectrometer for the measurement of background neutrons as produced by cosmic rays in the atmosphere is described. Organic scintillation liquid which fills the spherical glass vessels of 47 and 107 mm i.d. is used as scintillator in the detector head of the spectrometer. The response spectra of the scintillators for monoenergetic neutrons of energy between 0.5 and 14 MeV are calculated and the calculation is examined by the experiments of d-d and t-d neutrons. The spectrum of the cosmic ray produced neutrons at sea level, which is obtained by a peeling-off method using the response spectra, is shown as an example. The ratio of the mean dose absorbed by the scintillator to the first collision dose is calculated by use of the response function. (auth)

12670 DIGITIZER FOR SPARK CHAMBER PHOTOGRAPHS. Nadelhaft, I.; Findley, R. W.; Carrigan, R. A. Jr. (Carnegie Inst. of Tech., Pittsburgh). Contract AT(30-1)-882. Nucl. Instrum. Methods, 48: 254-60(1967).

An inexpensive measuring machine, for use in the analysis of spark chamber events, was constructed and operated at this laboratory. The machine is connected on line to a PDP-7 digital computer which accepts and analyzes information coming from the digitizer. Communication between operator and computer is accomplished through a typewriter. The digitizer consists of a digital voltmeter which reads a pair of voltage differences cor-

responding to the x-y coordinates of the point being measured. The voltages are generated by a drafting apparatus to which are attached two long slide-wire resistors. The operator moves a reticule to the desired point and this in turn causes the slide contacts to move along the appropriate resistances. The least count of this machine is 5×10^{-3} inch and the useful area is a 15 in. × 15 in. It takes about 1 sec to digitize a point. This machine was in operation for about one year without breakdowns. (auth)

12671 INVESTIGATIONS OF THE DISCHARGE MECHANISMS OF SELF-QUENCHING GEIGER-MUELLER TUBE COUNTERS. Huster, Erich; Franke, Heinz Guenter; Krafft, Otfried; Rohe, Karl Heinz (Univ., Muenster, Ger.). Forschungsber. Landes Nordrheim-Westfalen, No. 1672, 1-37(1966). (In German).

The discharge of a counter was propagated by photoeffect along the counter tube by the photons which arrived in the discharge avalanche at the wire. In cell-quenching counters energetic uv quanta arise which are absorbed by various processes in the quenching vapor. Numerous photons which are practically not absorbed by the counting gas are also produced and their energy supplements the photoeffect at the cathode. A study was made to determine which photons propagate the discharge, that is, whether the discharge is propagated by photoeffect in the gas in a narrow zone close to the wire quasicontinuously in many small steps or by photoeffect at the cathode in some large steps. It appears possible that those propagation forms (wire and mantle components) occur. The clarification of this question appears not only significant physically and for the scientific use of counters but also for counter development. The experiments described in the present study showed that both propagation forms occur but that the wire components play the preponderant role. This was shown by measurements on a counter with a coaxial rating between wire and mantle. If the grid potential is negative with respect to the mantle the grid acts as a counter cathode. The input voltage of this counter with 3% covering does not vary from that of a counter of 100% covering. Photoelectrons from the cathode are therefore not necessary for the propagation of the discharge. The statistical distribution of the transmission time of the discharge shows under normal conditions a very sharp maximum. By subdivision of the counter cathode into many fractions, the space-time pattern of the discharge was followed. This shows that the discharge was preponderantly quasicontinuous. Studies made separating the two propagation components gave essentially the same results as the usual experiments. (J.S.R.)

12672 NEW MEASURING ARRANGEMENTS FOR MONITORING RADIOACTIVITY IN AIR AND WATER. Kosmowski, Alfred. Wasser, Luft Betrieb, 10: 469-71(1966). (In German).

The latest measuring devices for monitoring radioactivity in air and water are briefly described. The devices considered are a monitoring device for α and β activities in exhaust air and for the determination of the β activities in the air space, monitoring devices for α and β activities in the air space, devices for monitoring of gaseous activities, device for the direct measurement of fission products in water, and water monitoring installations. (J.S.R.)

12673 DETECTOR EFFECTS ON THE STATISTICS OF NEUTRON FLUCTUATIONS. Osborn, R. K.; Nieto, J. M. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 26: 511-16(Dec. 1966).

Detector effects on the statistics of neutron fluctuations are studied. The problem is formulated in a general way, thereby making it applicable in principle to a large variety of systems. As an illustration of these effects, however, expressions are obtained for the power spectral density and the cross power spectral density assuming gas-filled BF_3 ionization chambers as detectors. The results show the anticipated break frequencies at the inverse of the average ion and electron collection times. Furthermore, the dependence of these detector break frequencies on chamber parameters such as density, temperature, and bias voltage is qualitatively revealed. (auth)

12674 SOME NEW IONOGRAPHIC DETECTORS OF THE FAMILY OF TRACE SOLID DETECTORS. Monnin, Michel; Besson, Henri; Sanzelle, Serge; Avan, Louis (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. B, 263: 1337-8(Dec. 7, 1966). (In French).

The characteristics of five new solid track detectors were outlined. Two of these detectors detect α particles. The corresponding energy threshold was determined. (tr-auth)

12675 TIME RESOLUTION IN SCINTILLATION COUNTERS. El-Wahab, M. A.; Gazzaly, M. (Alexandria Univ., Egypt). Nuovo Cimento (10), 47B: 56-71(Jan. 11, 1967).

Third and fourth spreads in scintillation counter time-resolution functions are introduced. Performing an exact calculation, assuming that the multiplier time dispersion can be characterized by third and fourth exponential decays following the scintillator decays, minima appear in the curves of width vs. n/N. The calculated resolving-time values are found to be in good agreement with the experimental resolution curves drawn as function of energy loss in the scintillator. Numerical values are given for the parameters of photomultipliers of the types XP1020, 56AVP and CBS7817. Time constants are also evaluated for plastic (NE102) and stilbene scintillators. (auth)

12676 WOUND MONITOR (Engineering Materials). (Du Pont de Nemours (E. I.) and Co. Savannah River Lab., Aiken, S. C.). (CAPE-1530).

15 drawings.

A portable lightweight monitor quantitatively measures Pu in wounds. Circuitry is contained on six plug-in circuit cards which facilitates monitor repair. Two scintillation detectors are used with the monitor. One detects 17 keV x-rays from Pu with a minimum detection level of 0.3 nCi of ^{239}Pu under $\frac{1}{4}$ in. of tissue. The other detector is sensitive to α particles and is used in locating Pu on the skin or in or near a wound. (For details see TID-4100 Suppl. 38). (F.S.)

12677 A DOSE METER FOR THE MEASUREMENT OF RADIOACTIVITY. Calvet, Edouard Jean Pierre British Patent 1,055,275. Jan. 18, 1967. Priority date Nov. 20, 1962, France.

A dosimeter is described for the selective measurement of γ and high-speed neutron fluxes in a swimming pool reactor. The dosimeter utilizes that property of certain materials which causes them to increase in temperature when subjected to specific types of radioactivity. The heat gain of the material is used to generate a proportional emf. A sealed casing contains 2 or more pairs of cells. In each pair, one cell contains material which is responsive to either γ or neutrons, and the other cell is air-filled and is used to record ambient water heating to provide a basis for comparison. Graphite is thermally responsive to neutron flux and lead to γ fluxes. (F.S.)

12678 LINEAR LOG RADIATION MONITOR /Q-2353/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1532).

14 drawings.

The linear log radiation monitor is used to monitor the cooling water at the High Flux Isotope Reactor. Geiger-Mueller counting tubes are employed. The housing is fabricated of 304 stainless steel 135 mm long and 22.98 mm ID. The 24V low voltage supply has an input impedance of 10 megohms, the 700V high voltage supply uses a 1000V electrostatic voltmeter. The output meter reads from 0 to 50 megaroentgens per hour. (For details see TID-4100 Suppl. 38). (F.S.)

12679 IMPROVEMENTS IN OR RELATING TO TIME MEASURING ARRANGEMENTS. Mey, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,055,936. Jan. 18, 1967. Priority date June 4, 1963, France.

A device is described which permits time-of-flight measurements of a large number of elementary particles simultaneously, by measuring time intervals having the same moment of origin, using the coincidences between the final pulses defining the intervals and the initial pulses delayed by varying periods. (B.G.D.)

12680 A METHOD FOR EFFECTING ANALYSIS OF FAST PHYSICAL PHENOMENA AND APPARATUS FOR CARRYING OUT THE METHOD. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,055,651. Jan. 18, 1967. Priority date Mar. 5, 1963, Austria.

A method is described for analysis of a fast physical phenomenon, such as a projectile explosion or a spark discharge or a cloud chamber reaction, according to which light emanating from the phenomenon is utilized to form at least two image-forming beams of light representing spatial coordinates of the phenomenon. (B.G.D.)

12681 DETECTOR. (to Harshaw Chemical Co.). British Patent 1,051,278. Dec. 14, 1966. Priority date Dec. 16, 1963, United States.

A radiation detector is described which comprises a scintillation crystal transparent to its own emanations, a photoconductive body (CdS or CdSe) positioned adjacent to and illuminated by the crystal, and a source of emf connected in a circuit with the photoconductive body for indicating conductance changes in response to the amount of illumination. (B.G.D.)

12682 IONIZATION CHAMBER FOR MEASURING HUMIDITY. Johannes, Eberhard; Netz, Volkhard; Frey, Wolfram (to VEB Vakutronik). British Patent 1,052,523. Dec. 21, 1966. Filed Feb. 26, 1964.

An ionization chamber is described for measuring humidity by means of neutrons and having concentrically arranged sleeve-

shaped electrodes or superimposed disc-shaped electrodes, where a source tube is concentrically surrounded by a slow-neutron sensitive chamber, and a source of fast neutrons is disposed in the source tube. (B.G.D.)

12683 IMPROVEMENTS IN IONIZATION CHAMBERS. Benoit, Roch; Restelli, Giambattista; Bertolini, Giancarlo (to European Atomic Energy Community). British Patent 1,052,558. Dec. 30, 1966. Priority date Nov. 4, 1963, France.

An ionization chamber is described having a main compartment and a subsidiary compartment leading therefrom, both compartments being gas tight and the subsidiary compartment having an access opening with a removable gas-tight cover, a specimen carrier operative for conveying specimens between the two compartments, the carrier having an aperture at a specimen-carrying station with the carrier to make a gas-tight closure around the aperture and around the access opening where the cover may be removed to obtain access to the station without breaking the gas-tightness of the main compartment. (B.G.D.)

Radiation Dosimeters

Refer also to abstract 12887.

12684 (AD-641913) FLUOR-PHOTODIODE GAMMA-RAY DOSIMETER. Final Report. Zatsick, M. R.; Katzenstein, H. S.; Friederichs, J.; Higa, R.; Underwood, J. (Solid State Radiations, Inc., Los Angeles, Calif.). Sept. 21, 1965. Contract N228-(62497)68124. 113p. (USNRDL-TRC-78). CFSTI $3.00 cy, $0.65 mn.

A fluor-photodiode gamma ray dosimeter, nicknamed Fluorad, was designed, fabricated, and extensively tested and calibrated. The instrument (sensor head plus recycling circuit) provides output pulses suitable for low sensitivity scaler inputs. The total count (x 10) corresponds to the integrated absorbed dose of a given gamma ray exposure in incremental steps of 10 rads (air) per count. The dosimeter is capable of monitoring both steady state or pulsed radiation fields over an intermediate dose rate range of 10–100,000 rads/sec. Energy calibration, using side-by-side dosimetry techniques, was carried out over the range 50 keV to 11 MeV. Various types of ion chambers and thermoluminescent dosimeters were used as the calibrating standards. The measured energy response relative to Co60 over the photon energy range, 100 keV to 10 MeV was virtually constant. An average absolute sensitivity of 1.5×10^{-8} C/rad was observed. The measured neutron response at 14 MeV was equal to 0.5 times the first collision dose in standard tissue. Other characteristics measured included: pulsed reactor fission neutron and gamma ray response, linearity of frequency vs. dose rate (or current), directional response, temperature range, saturation and recovery time, spurious pulse rate, and radiation effects. The variations in reproducibility for fixed conditions were less than plus or minus 1%. (auth)

12685 (COO-1105-106) THERMOLUMINESCENT READING INSTRUMENT FOR MILLIROENTGEN EXPOSURE LEVELS. Suntharalingam, N.; Zimmerman, D. W.; Kenney, G. N. (Wisconsin Univ., Madison). July 15, 1965. Contract AT(11-1)-1105. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An instrument is described for measurement of thermoluminescence from single crystals exposed to low levels of radiation (down to below 10 mR). The instrument consists of a method of heating the crystals and a photomultiplier detector system for measuring the emitted light. (B.G.D.)

12686 (COO-1105-108) A SIMPLE TLD READER UTILIZING A CONVENTIONAL SCALER. Kenney, Gordon N.; Cameron, J. R.; Vought, Clifford (Wisconsin Univ., Madison. Dept. of Radiology). July 15, 1965. Contract AT(11-1)-1105. 3p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A simple thermoluminescent dosimeter reader is described which connects to a conventional scaler. The system consists of a sample heater, a photomultiplier tube (PMT), a simple analog-digital (A-D) circuit for the PMT anode current and a scaler to total the digital output giving a measure of the total thermoluminescence. The reader is designed to connect to a conventional scaler which supplies the positive high voltage for the PMT and counts the pulses produced by the A-D circuit. (B.G.D.)

12687 (UCRL-50007-66-1, pp 1-7) PHOTO- AND THERMOLUMINESCENCE OF LiF: (Mg, Ti). Zimmerman, D. W.; Jones, D. E.; Petrock, K. F. (California Univ., Livermore. Lawrence Radiation Lab.).

The existence of the luminescent center in the thermoluminescent process in LiF and some of its optical properties are discussed. Studies reported include thermoluminescence, absorption, and photoluminescence measurements on a limited number of LiF single crystals containing added impurities. A correlation is shown between the photo- and thermoluminescence of the center, which is related to Ti dopant. (B.G.D.)

12688 (UCRL-50007-66-1, pp 25-7) MEASURING COLLIMATED NEUTRON BEAMS WITH THE REMMETER. Prevo, C. T.; Bryan, J.; Cate, J. L. (California Univ., Livermore. Lawrence Radiation Lab.).

The response of the Anderson-Brown remmeter to a collimated neutron beam (1.225 $in.^2$ at 36 in. from the beam port) at the Livermore Pool-Type Reactor was measured. These measurements were taken with the beam axis perpendicular to the remmeter axis for various axial and radial positions. (B.G.D.)

12689 (UCRL-50007-66-1, pp 28-36) THERMOLUMINESCENT MATERIALS FOR PERSONNEL MONITORING IN GLOVED BOX OPERATIONS. Jones, D. E.; Petrock, K. F.; Denham, D. H. (California Univ., Livermore. Lawrence Radiation Lab.).

Several mechanical configurations of LiF and BeO that have been studied for application to personnel dosimetry problems are discussed. The choices of the systems were based on availability and the desire to retain the well established attributes of LiF TLD powder. (B.G.D.)

12690 (UCRL-50007-66-1, pp 44-5) LOW HUMIDITY INDUCED FOG IN PHOTOGRAPHIC FILMS. Kathren, R. L.; Samardzich, B. G. (California Univ., Livermore. Lawrence Radiation Lab.).

The possible induction of fog in photographic materials by low humidity was investigated. Since this could have an effect on personnel monitoring with film dosimeters groups of film were studied at different atmospheres at 22 ± 3°C. The atmospheres were: dry air, dry nitrogen, dry 40% oxygen–60% nitrogen, and air (relative humidity 35 ± 5%). (B.G.D.)

12691 (ORNL-tr-1476) MODEL 1232-01 SCINTILLATION DOSIMETER FOR MEASUREMENT OF THE DOSAGE RATE OF X- AND GAMMA-RADIATION. Arsaev, M. I.; Osipov, B. F.; Sulimova, H. E. Translated for Oak Ridge National Lab., Tenn., from a Russian Report. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80.

The advantages of scintillation dosimeters over ionization for measurements of the dosage rate are examined and a portable dosimeter for measurement of the dosage rate of x- and gamma-radiation in the range of effective quantum energies of 30 to 3000 keV and dosage rates of 0.1 to 300 microroentgens/second is described. In that range of quantum energies, the energy dependence of the dosimeter does not exceed ±15%. The volume of the detector is 37.5 cc. The readings of the dosimeter do not depend on the angle of incidence of the radiation flux in the limits of 0–180° in the working range of energies. The response time for the indications does not exceed 5 seconds in the most sensitive range. The dosimeter is capable of operating in a temperature range of –10 to +40°C and in a humidity of up to 90%. Power is obtained from a 220 volt ac network or from RTs-85kh elements. The service life with a single assembly is not less than 100 hours. It weighs about 2.5 kg. (auth)

12692 DOSIMETRY PROPERTIES OF NEW PHOSPHATE GLASSES FOR ROUTINE DOSIMETRY. Maushart, R.; Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 12: 568-73(Nov. 1966). (In German).

The dosimetry properties of low-dose sensitive phosphate glasses, especially Japanese Yokota glasses, French CEC glasses, and German Schott glasses, were determined. The energy dependence of dose indication, predose, high-dose behavior, reutilization of the glasses after interim quenching of the measured values, kinetic behavior relating to the storage stability of measured values (changes of the measured values after irradiation at temperatures of 20°C, 100°C and 400°C) as well as fluorescence spectra of four different kinds of glasses were investigated. (auth)

12693 MICRODOSIMETRY. Rossi, H. H. (Columbia Univ., N. Y.). pp 81-95 of STI-DOC-10/58.

Methods used for measurements of the microscopic distribution of energy density in irradiated tissues are discussed. It is pointed out that deviations from the average energy density in irradiated tissues can often be extreme and that measurements of radiation quality as expressed by local variations in energy density can furnish information on the size of sensitive sites in irradiated tissues and the energy requirements for their inactivation. The use of spherical tissue-equivalent proportional counters that can simulate tissue spheres having diameters down to a few tenths of a micron for the determination of the spectrum of energy losses in irradiated materials is discussed. When the pulses arising in a spherical proportional counter are analyzed by means of a multichannel analyzer an event spectrum is obtained from which a number of other distributions may be derived that are useful in the correlation of physical and biological data. A list of microdosi-

metric variables, references to experimental techniques, and results of measurements of event size, event frequency, and local energy distribution for ^{60}Co γ radiation and neutrons of various energies are included. The influence of LET on RBE and the limitations involved when the LET spectrum is used to calculate local energy density are discussed. (C.H.)

12694 RADIATION DOSIMETRY IN SMALL CAVITIES USING THERMOLUMINESCENCE IN LITHIUM FLUORIDE POWDER. Benner, Sven; Johansson, M.; Lindskoug, B. (Univ., Goteborg). Nature, 212: 535-6(Oct. 29, 1966).

A technique with permanently filled containers was developed. Teflon tubes were partly filled with lithium fluoride powder while in an atmosphere of nitrogen. If radiographic or fluoroscopic localization of the probe was required, gold indicators were inserted; these were separated from the lithium fluoride by Teflon plugs. One section of the tube at a time was heated for read-out. The sensitivity of measurements was found to vary with the number of exposures and read-outs. (H.L.W.)

12695 IMPROVEMENTS IN OR RELATING TO CONTAINERS FOR DOSIMETERS. (to Manufacture Belge de Lampes et de Materiel Electronique). British Patent 1,050,975. Dec. 14, 1966. Priority date Sept. 10, 1962, Belgium.

A reusable container is described for radiation dosimeters. The container is comprised of an envelope permeable to ionizing radiation and opaque to visible light. (B.G.D.)

Radiometric Instruments

12696 (ORNL-TM-1687) HFIR HOMOGENEITY SCANNER, PRODUCTION MODEL, OPERATING AND MAINTENANCE MANUAL. Reynolds, J. W.; Shipp, R. L.; Sliski, T. F.; Longaker, W. H.; Klindt, K. K. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Fuel material in an HFIR fuel plate is U_3O_8 dispersed in aluminum, resembling an airfoil in cross section. To ensure uniform generation of heat within the plate, all plates must be tested (nondestructive) to determine that the U_3O_8 content is within specified limits. The HFIR Homogeneity Scanner was developed for this purpose. It is a density-thickness gauge that scans a plate with a highly collimated, 0.062-in.-diam beam of x rays and detects those transmitted through the plate. Variations in the transmitted beam due to absorption in the fuel plate are used as a measure of fuel density. The operation of this machine and maintenance procedures for the electronic components are described. (auth)

12697 (STI-PUB-21/20) RADIOISOTOPE INSTRUMENTS IN INDUSTRY AND GEOPHYSICS. Bibliographical Series No. 20. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 428p. IAEA: $8.50; Austrian Schillings 220,-; £3.9.0.; F Fr 41,70; Dm 34,-.

A bibliography, No. 20 in the Bibliographical Series, concerned with the design and applications of radioisotope instruments is presented. References and abstracts were obtained from Nuclear Science Abstracts and from Radioisotopes in World Industry. References are classified by technique and field of application. Industries are classified according to the International Standard Industrial Classification of All Economic Activities. (R.C.K.)

12698 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART IV. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 370, 241-4(Nov. 1966). (In German).

The application of γ radiations to measurements of film thickness, including factors that affect the choice of γ emitter, the radiation detector, optimal geometric arrangement, and procedures that are pertinent to use of penetrating radiation for measurements on steel rolling stock are discussed. Statistical variations inherent in these procedures are derived. Measurement sensitivity and preparation activity is plotted as functions of steel thickness. Backscatter procedures are discussed. Pulse frequency and measurement uncertainty as a function of steel thickness for γ backscattering is illustrated for a photomultiplier-sieve amplifier arrangement. A light pipe-photomultiplier-cathode follower array for γ backscatter measurements is described. Backscatter intensity as a function of angular distance for steel plates and tubes is plotted in arbitrary scale units, and using steel thickness as a parameter, backscatter intensity is plotted as a function of plating thickness. Backscatter intensities for ^{137}Cs and ^{60}Co are compared as a function of steel thickness. (BBB)

12699 FLOW RATE MEASUREMENTS IN HYDROPOWER PLANTS BY MEANS OF RADIOISOTOPES. Knapp, M.; Restarovic, S.; Loncaric, J. (Institut za Naftu Zagreb). Int. J. Appl. Radiat. Isotop., 18: 101-9(1967).

Radioisotopes have been utilized to measure flow rates at two large Yugoslav hydroelectric power plants. Measurements taken have provided valuable information about the turbine efficiency and water power value of the plants. The advantages of the method, results obtained and hazards involved are discussed. (auth)

12700 BUOYANCY TYPE APPARATUS FOR DETERMINING HYDROGEN CONTENT IN FLUIDS WITH GAMMA RAYS. Amrehn, Hermann (to Chemische Werke Huels, AG). U. S. Patent 3,280,327. Oct. 18, 1966. Priority date July 14, 1961, Germany.

A buoyancy type apparatus is described for continuously indicating the ratio of hydrogen atoms to other atoms in flowing fluids or liquids (H/R) using high-energy gamma rays. The apparatus consists of a hollow container, preferably a vertically disposed tube that is closed on top and bottom. The top serves as a detector window, and a gamma radiation detector is disposed on the top of the tube at this window. A liquid outlet is located close to the top of the tube near the window, and the liquid inlet is located near but not at the bottom of the tube so that a calm zone is defined between the bottom of the tube and the liquid inlet. A regularly shaped member containing a gamma source near the center or at least on a vertical line taken through the center of gravity of this floating member floats freely in the calm zone. A buoyancy adjustment chain is suspended from the bottom of the floating member, and the chain is partially suspended freely and partially lying on the bottom of the vessel during operation. With changing density of fluids, the distance between the source and detector changes to give an indication of the density of the fluid, and thus a ratio of atoms. (B.L.M.)

12701 IMPROVEMENTS RELATING TO SCINTILLATION APPARATUS FOR THE EXAMINATION OF MATERIAL. Shemmans, Malcolm John; Wycherley, John Ralph; Townend, Gordon Howard (to G.K.N. Group Services Ltd.). British Patent 1,052,262. Dec. 21, 1966. Filed Aug. 30, 1962.

A scintillation apparatus is described for examining various materials, comprising of the combination of a source of penetrating radiation directed along a path and a screen, composed of light transmitting material loaded with a scintillating medium, which is separated from the source for detecting the radiation. The materials to be examined are inserted between the source and detector. (B.G.D.)

Miscellaneous Instruments and Components

Refer also to abstracts 12316, 12423, 12600, 13097, 13132, and 13456.

12702 (AD-639328) A MICROWAVE CORRELATION RADIOMETER. Instrumentation Papers. Goggins, William B. Jr. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Aug. 1966. 32p. (AFCRL-66-534; AFCRL-IP-108). CFSTI $3.00 cy, $0.65 mn.

A practical microwave correlation radiometer was built and tested. Feedback was used to ensure stability and make it unnecessary to match receiver channels. The rms temperature deviation was derived and found to be square root of 2 times that of a total power radiometer. Two separate systems to provide an ac multiplier output were built and evaluated. In one, the receiver channels were tuned to a slightly different frequency while in the other, phase reversal in one channel at an ac rate provided the modulation. The latter method proved easier to instrument. (auth)

12703 (ANL-7275) PROCEEDINGS OF THE AMU-ANL WORKSHOP ON HIGH-VOLTAGE ELECTRON MICROSCOPY, JUNE 13-JULY 15, 1966. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 198p. (CONF-660646). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and construction of high voltage electron microscopes are discussed. Topics included are high voltage, lens design, specimen facilities and recording, and structural problems. (B.G.D.)

12704 (BNL-10904) PALMUD: A PROGRAM TO HANDLE ONE AND TWO-DIMENSIONAL SPECTRA. Mariscotti, M. (Brookhaven National Lab., Upton, N. Y.). Dec. 30, 1966. Contract AT(30-2)-Gen-16. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A program (PALMUD) is described which is to be used with either one or two-dimensional data obtained from multichannel analyzers. It handles groups of up to 1600 channels in the first case, while in the latter, data must be arranged in 16 × 1024, 32 × 512, 64 × 256, or 128 × 128 format, i.e., 16384 channels per group. (B.G.D.)

12705 (EGG–1183-336) 3344 TW OSCILLOSCOPE, LE 13540-1, TYPE OS-31. Technical Manual Number B-3422. Kennedy, F. D. (Edgerton, Germeshausen and Grier, Inc., Boston, Mass. Systems Div.). Sept. 30, 1966. Contract AT-(29-1)-1183. 123p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The 3344 traveling-wave oscilloscope which was designed as a wide band indicator for recording high-frequency transient signals that occur in the nanosecond or subnanosecond rise time regions is discussed. Topics included are description and purpose, specifications, operation, operation principles, maintenance, and installation. (B.G.D.)

12706 (INR–682/I-A/PL) ELECTRONIC DEVICES FOR SEMICONDUCTOR RADIATION DETECTORS. Dakowski, Miroslaw; Konador, Gerard (Institute of Nuclear Research, Warsaw (Poland)). Dec. 1965. 24p. Dep.

The necessity of construction of the family of charge sensitive low noise preamplifiers is described. This family allows utilization of the different properties of semiconductor detectors. Four schemes of such preamplifiers and the principle of their design are presented. The diagram of universal supply unit for detectors and preamplifiers is added. (auth)

12707 (INR–747/II/PS) COLLIMATORS IN NEUTRON TIME-OF-FLIGHT POWDER DIFFRACTOMETRY. Holas, A. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 26p. Dep.

The role of collimators in the time-of-flight neutron diffractometry is discussed. Special attention is paid to their contribution to intensity and resolution. The cases of limited width of a collimator and absorbing sample are considered separately. (auth)

12708 (N–66-26148) AMPLIFIER FOR USE WITH SOLID STATE RADIATION DETECTORS IN SPACECRAFT APPLICATIONS. Marshall, J. H. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 30, 1964. Contract NAS7-100. 23p. (NASA-CR-74885; JPL-TM-33-190). CFSTI $3.00 cy, $0.65 mn.

A charge-sensitive amplifier for use with solid state radiation detectors is described. Particular emphasis is placed on an analytic design approach so that optimal gain stability and resolution can be obtained for a minimum of weight and power. Measured results for an amplifier constructed for laboratory use are presented for comparison with the theoretical analysis. Presently this amplifier is being used in the second-generation alpha scattering experiment on Surveyor. (auth)

12709 (N–66-37574) ELECTRIC FIELD METER FOR ROCKET AND SATELLITE USE. Potter, Wentworth Edwards (New Hampshire Univ., Durham. Dept. of Physics). Sept. 1966. 99p. (NASA-CR-78389; UNH–66-4). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The evidence for the existence of electric fields in the ionosphere and magnetosphere is discussed. It is seen that the charge particle motions of the atmospheric dynamo system cause electric fields in the ionosphere while plasma convections produce electric fields in the magnetosphere. The auroral and electrojet current systems are studied in relation to the electric and magnetic fields. It is proposed to make, in situ, measurements of these electric fields estimated to be 0.1 to 100 mV/m using a high impedance differential electrometer amplifier. A high impedance field effect electrometer amplifier was designed, and a description of this as well as of a rocket experiment for measuring ionospheric electric fields is presented. The system will first be used on sounding rockets and later on satellites. A unique, unfurlable probe system will be used. The accuracy of the system is expected to be ±50 to ±5% for measurements of 10 to 100 mV. (auth)

12710 (N–66-39339) ELECTRON MICROSCOPY WITH SUPERCONDUCTING LENSES. Fernandez-Moran, H. (Chicago Univ., Ill.). 1966. 7p. (NASA-CR-78745). CFSTI $3.00 cy, $0.65 mn.

Two approaches for improving the design of electron microscopes are reported. High voltage developments are aimed at increasing resolution as well as penetration; this means thicker specimens, useful to both biological scientists and metallurgists. As for the second approach, superconducting lenses operating at cryogenic temperatures are found to give exceptional stability and high resolution; this means sharper electron micrographs at relatively low voltages. Also, this facilitates long exposures at low beam intensity, which produce fine detail even with relatively large fields. Details on problem area research, industrial and medical applications, and marketing possibilities are included. (STAR)

12711 (NP–16430) EMISION SECUNDARIA. DISENO, CONSTRUCCION Y ESTUDIO COMPARATIVO DE UN MULTIPLICADOR LINEAL DE ELECTRONES. (Secondary Emission, Design, Construction, and Comparative Studies of Linear Electron Multiplier). Dominguez Alvarez, Hector Angel (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1966. 47p. (In Spanish). Dep. mn.

Thesis.

The study, design, and construction of an electron multiplier with linear geometry are presented. The physical characteristics of secondary emission phenomena, necessary for the design of a multiplier, are discussed. The general characteristics of known electron multipliers having good efficiency are considered with the purpose of comparing their geometries and efficiencies with that of the electron multiplier proposed in the present study. (J.S.R.)

12712 (NYO–3421-8) PHOTOMULTIPLIER INVESTIGATION. Final Report, June 15, 1964–June 15, 1966. Smith, H. M. Jr. (David Sarnoff Research Center, Princeton, N. J.). Aug. 9, 1966. Contract AT(30-1)-3421. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two problems often encountered by users of photomultiplier tubes today are those of dark pulses and gain shift with count rate or short term stability. Investigations were made on the causes of these problems and the results to date are summarized. With regard to the dark current problem, a survey showed that all tubes appear to exhibit three types of dark pulses; namely, thermionic electron pulses, nonthermionic single electron pulses, and nonthermionic multi-electron pulses. The multi-electron pulses were studied in great detail and two methods were found which reduce their number significantly. Appropriate instrumentation was developed for the study of the stability problem. A survey of commercial tubes as well as special laboratory tubes was made and some conclusions with regard to this problem are also included. (auth)

12713 (NYO–3622-6) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 31, October 1, 1966–November 30, 1966. (Aeroprojects, Inc., West Chester, Pa.). Dec. 1966. Contract AT(30-1)-3622. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An ultrasonic instrument for incipient boiling detection was used to acquire cavitation threshold power data during tests conducted in liquid potassium at the Mine Safety Appliance Research Corporation facilities. Statistical analysis of the data indicated generally good correlation with hypothetical calibration lines derived from physical properties of potassium. Brief cavitation studies conducted in water indicated that an unterminated acoustical transmission system merits further testing with liquid metal. Consideration was given to the probable practical application of cavitation threshold determinations. Continued studies of the frequency-change approach to ultrasonic thermometry were undertaken to determine the effect of gradient form on the frequency-vs.-temperature relationship, and this approach appears to permit instrument operation irrespective of gradient form. (auth)

12714 (ORNL–4054) ANGLE CALCULATIONS FOR 3- AND 4-CIRCLE X-RAY AND NEUTRON DIFFRACTOMETERS. Busing, William R.; Levy, Henri A. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods are derived for calculations useful in the operation of 3- and 4-circle x-ray or neutron single-crystal diffractometers. These include: establishing the sample orientation from the cell parameters and the observed angles for two reflections, or from the observed angles for three reflections only, calculating the angles for observing a given reflection either in a special setting or at a specified azimuthal angle, obtaining the vectors needed for calculating absorption corrections, and using observations of several reflections to refine cell and orientation parameters by the method of least squares. Algorithms for many of the procedures are presented in an appendix. (auth)

12715 (SCTM–201-58(14)) CERAMIC TRIPPATRON. Creveling, R. (Sandia Corp., Albuquerque, N. Mex.). Nov. 27, 1958. Contract AT(29-1)-789. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Trippatron is a cold-cathode discharge tube designed to switch kiloamperes of current in the 1- to 3-kilovolt range. The low-pressure helium fill of the tube is ionized in such a way that the high voltage is confined until low-energy trigger voltage allows a long-path discharge to take place. This method of operation results in fast, low-jitter arc conduction. Two designs using ceramic and metal were tested and found to be better than the glass prototype developed earlier. The use of radial slots in the cathode seems to be an improvement over the holes used in the glass Trippatron. The ceramic Trippatron is small, compact, and rugged. Because of its ceramic construction, the tube is expected to withstand 100,000 g. Since it is simple to build, its cost is low. (auth)

12716 (UCRL–13258) TIME MEASURING DEVICES. Matchette, E. E. (Bendix Corp., Kansas City, Mo.). July 1966. Contract AT(29-1)-613. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Univ. of California, Livermore.

The functional and operating characteristics of available time-measuring devices are described. Both laboratory and commercial types are listed, and parameters for specific applications are discussed. (auth)

12717 (UCRL–50165) CALIBRATION TECHNIQUES FOR LASER BEAM MONITORS. Davis, Donald T. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 16, 1966. Contract W-7405-eng-48. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Procedures are presented for calibrating pulsed-laser beam monitors (sampling type) in terms of energy and power per volt using an absorption-type calorimeter as the standard. Techniques are described for minimizing absolute and random errors in data acquisition. A comprehensive error analysis shows how the absolute and relative accuracies of the device depend on calibrating over a finite number of observations. (auth)

12718 (NP-tr–1484) A TROCHOID SPECTROMETER FOR MEASURING ION ENERGY DISTRIBUTION IN PLASMAS. Bastain, C. (Kernforschungsanlage, Juelich (West Germany)). Translated for U.K.A.E.A., Culham Lab., Abingdon, Eng., from report JUL–200-PP. 17p. (CTO–329). Dep. mn. JCL $1.60 fs, $0.80 mf.

An ion spectrometer for use in plasma physics is described. The analyzing structure is that of Bleakney and Hipple, combining crossed uniform electric and magnetic fields which provide mass focusing and energy selection. For a given mass of the ions, four stigmatic images of the inlet diaphragm appear on the spectrogram. They correspond to ions of four definite energies which are recorded simultaneously. A spectrometer of this type is designed for proton energies in the range from 500 eV to 25.0 keV. The protons can be recorded either on a photographic emulsion, by four Faraday cups, or by four scintillations counters. (auth)

12719 FAST, PUNCHED-CARD READOUT SYSTEM FOR PULSE-HEIGHT ANALYZERS. Euler, B. A.; Phelps, P. L.; Covell, D. F. (Naval Radiological Defense Lab., San Francisco). pp 291-4 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

An IBM-523 Gang Summary Punch in conjunction with a specially built buffer unit was used to provide punched-card readout from a 256-channel pulse-height analyzer. Complete readout was accomplished in 12 sec. Use of punched cards contributed the additional advantages of an easily organized data file and ready accessibility to the data. The card-punch buffer unit was capable of converting binary-coded decimal notation (BCD) to binary notation. It had an eight-word AND gate matrix that allowed the insertion of seven record-identification and information words into the punch card readout along with the 256 words of pulse height data. (auth)

12720 TWO-CHANNEL SCHEME FOR SYNCHRONIZED RECORDING OF NUCLEAR FISSION FRAGMENTS OF STANDARD AND TESTED SAMPLES. Lobanov, E. M.; Chalov, P. I.; Mamyrov, U. At. Energ. (USSR), 21: 204-5(Sept. 1966). (In Russian).

A two-channel scheme for synchronous measurements of fission fragment production rates of standard and tested samples in a neutron beam with varying intensity and energy is presented. The tabulated results for cadmium ratio for 18 uranium standards, with identical isotope content, coated on aluminum and stainless steel irradiated in a horizontal channel of VVR-S reactor with 1.75×10^8 neut/cm^2 sec neutron beam showed that the two-channel recording scheme permits determination of the isotope content by fission fragments of nuclear fission on neutron beams by eliminating the effects of varying intensity and energy spectrum on the measurements. The method proved to be accurate and rapid. (R.V.J.)

12721 FURTHER NOTE ON THE QUASI-STATIC THEORY OF A CYLINDRICAL IMPEDANCE PROBE FOR MAGNETO-PLASMA. Wait, James R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 253-6 (Feb. 1967).

In a previous paper, an expression was derived for the fields of two parallel line charges in an anisotropic medium. This derivation is extended to include the effect of a sheath at the boundary of the plasma next to the probe. The influence of a cylindrical glass container for the dielectric rod is also considered. (M.O.W.)

12722 TIME DISCRIMINATOR FOR FAST PHOTOMULTIPLIER PULSES. Conrad, R. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 48: 229-35 (1967). (In German).

A discriminator for time measurements is described which is supplied with fast photomultiplier signals (e.g., 56 AVP or XP 1040) and forms unit pulses. It consists of a zero crossing circuit and a limiter followed by a tunneldiode discriminator. The zero crossing circuit is coupled directly to the anode and the last dynode. Their signals are added in a balanced bridge to prevent reflections in the cables. The tunneldiode of the discriminator is biased in the upper state and is switched down firstly by the zero crossing signal and switched back when the signal is crossing zero. Therefore in this mode it is possible to compensate the timeshift down to the threshold. The electronic timeshift is less than 300 ps within a voltage range from threshold (≈ 100 mV) up to 20V. The time resolution measured with γ-γ coincidence of ^{60}Co using two time discriminators without slow window channels was 0.53 ns within an amplitude range of 1 : 100. In fast-slow-technique a resolution of 0.3 ns was obtained measured with 56 AVP and Naton scintillators. (auth)

12723 SOLID-STATE LOG n-PERIOD SYSTEM. Byrd, J. S. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Instrum. Methods, 48: 296-300(1967). (DP-MS–66-7).

A log n-period system with all solid-state components was designed and tested. The logarithmic converter uses the logarithmic transfer relationship between the short-circuit collector current and the base-emitter voltage of a silicon transistor to convert an exponentially varying ion chamber current to a linear voltage. The operational amplifier in the logarithmic converter has a junction-type field-effect transistor at its input for very high input impedance. To obtain the reactor period, the linear voltage is differentiated by a circuit whose damping is controlled by the level and rate of change of its input. This circuit adequately protects a nuclear reactor during startup. The overall system is accurate, reliable and stable. (auth)

12724 VARIABLE PULSE WIDTH CIRCUIT FOR DRIVING COUNT RATE CIRCUITS. Jones, A. R. (Chalk River Nuclear Labs., Ont.). Nucl. Instrum. Methods, 48: 345-6(1967).

The design and performance of a variable pulse width circuit for driving count rate circuits is discussed. A schematic of the circuit is presented. (B.G.D.)

12725 PROTON PRECESSION MAGNETOMETER. Bhargava, B. N. (Colaba Observatory, Bombay); Kasiviswanathan, G. A. Indian J. Meteorol. Geophys., 17: 457-62(July 1966).

The design and construction of a simple portable proton precession magnetometer are described. Except for the signal amplifier, the instrument is transistorized. The accuracy of measurement of absolute value of the earth's total field with the magnetometer is ±1 γ. The precession signal voltage from the sampling coil is amplified and squared by a Schmitt trigger circuit, the output of which drives 10 stages of binary dividers. The first pulse in the output of the chain of dividers opens a gate allowing pulses from a 100-kc crystal oscillator to pass to a pulse counter. The pulse immediately following the opening pulse closes the gate. By suitable feed back of this closing pulse any following pulse is prevented from opening the gate again. For the next observation, a manual resetting is necessary. The number of 100-kc pulses counted are used to compute the scalar field. With an accuracy of pulse counts of ±1 in 60,000, the observed value of the earth's field is correct to within ±1 γ. (BBB)

12726 LANGMUIR CALORIMETRIC PROBE TO DETERMINE AVERAGE ENERGY PER ION IN A TENUOUS PLASMA BEAM. Bowditch, David N. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 362-3(Feb. 1967).

The design and performance characteristics of a Langmuir calorimetric probe for measuring average ion energies in a plasma thruster are discussed. (M.O.W.)

12727 DETECTION OF INERTIAL EFFECTS WITH SUPERCONDUCTING INTERFEROMETERS. Papini, G. (Univ. of Saskatchewan, Regina). Phys. Lett., 24A: 32-3(Jan. 2, 1967).

It is shown that superconducting interferometers may be useful in detecting inertial effects and in accurate rotation rate measurements. (auth)

12728 DUAL PATH COLORIMETER (Engineering Materials). (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). (CAPE–1531).

4 drawings.

An in-line process differential colorimeter, with an automatic check system is used in analyzing Pu(IV) in the presence of Cr(III) in the range of 0.1 to 2.5 g Pu per liter. The instrument measures the difference in light transmittance at two wavelengths, 580 and 660 nanometers. These wavelengths are characteristic of Pu(IV)

and the difference in transmission is a measure of the Pu concentration. The check system provides an alarm if a malfunction of the colorimeter develops, ensuring elimination of the possibility of "control runaway" when the instrument is used in process control applications. (For details see TID-4100 Suppl. 38). (F.S.)

12729 APPARATUS FOR MEASURING COUNTING RATES. (to Japan Atomic Energy Research Inst.). British Patent 1,053,987. Jan. 4, 1967. Priority date Mar. 30, 1963, Japan.

A device is described for measuring cyclic variations in a high-speed counting rate under the control of a zero time signal repeatedly produced in synchronism with the beginning of each cycle of variation, comprising of a delay circuit arranged to transmit the zero time signals of successive cycles with different delays, a gate circuit triggered by the output of the delay circuit for passing input signals during sampling intervals of constant time duration but with different delays, a high speed scaler circuit for counting the unput signals that has passed through the gate circuit, and a memory device having a plurality of addresses for memorizing the count numbers of input signals for respective times in respective addresses corresponding to different sampling intervals in the cycle of variation. (B.G.D.)

12730 IMPROVED REMOTE CONTROL MICROSCOPE. (to Gesellschaft fuer Kernforschung m.b.H.). British Patent 1,051,385. Dec. 14, 1966. Priority date Feb. 21, 1964, Germany.

A remote-controlled microscope is described for examining radioactive materials in shielded areas. Generally the microscope is situated partly behind a radiation shield with an operating and inspection device projecting out of the screened space and connected to the microscope by means of tubes and flexible shafts. (B.G.D.)

12731 DEVICE FOR IRRADIATING LIVING VISCERA. Tateishi, Kazuma (to Tateisi Electronics Co.). Japanese Patent 1965-20154. July 13, 1965. Filed Mar. 24, 1962.

An improved device is proposed for irradiating living viscera. The device includes a cylindrical capsule with a collimator, made of a radiation-shielding material; and a movable capsule within the said capsule, with an irradiation hole, containing a radiation source. The first capsule is surrounded with cables made of an elastic plastic material. The elastic cable to operate the movable capsule is connected at the one end to the same (movable) capsule through the fixed capsule; the other end of this cable is taken outside through a cable. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 12649 and 13290.

12732 (AD-639610) ELECTRON TUBES RADIATION RESISTANT PILOT LINE PRODUCTION. Final Progress Report, May 21, 1963–March 31, 1966. Buchanan, William A. (Tung-Sol Electric Inc., Bloomfield, N. J. Electron Tube Div.). June 10, 1966. Contract DA-36-039-AMC-01476(E). 137p. CFSTI $3.00 cy, $0.65 mn.

Work required for the delivery of engineering samples, tube types 5886, 6360, 6205, and 6080WB, was completed with the exception of the high temperature (500°C) life testing of tube types 6360, 6205, and 5886 in alumino-silicate glass. The primary objective of the contract—to establish the techniques and controls for producing tubes with alumino-silicate enclosures—has been achieved. As a result of the information gained from the radiation tests and high temperature life tests, it became apparent that further efforts to establish pilot run capabilities would not be feasible. (auth)

12733 (AD-639962) LINCOLN ACCELERATOR LABORATORY. Mack, Charles L. Jr. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Sept. 2, 1966. Contract AF 19(628)-5167. 36p. (ESD-TR-66-430). CFSTI $3.00 cy, $0.65 mn.

A complete technical description of the Lincoln Accelerator Laboratory is given. The primary purpose of the laboratory is to conduct radiation-effects studies for space vehicles and components. Particle fluxes up to 68 inches in diameter are provided in a solar-vacuum chamber. These can be either monochromatic electrons at any energy from 300 keV to 4 MeV; electrons distributed in a Van Allen energy spectrum from 40 keV to 4 MeV, or monochromatic protons at any energy from 50 keV to 4 MeV. The general-purpose capabilities of the laboratory are described, equipment listed, and information concerning the facilities is given to enable the investigator to design his experiment for greatest convenience and compatibility. (auth)

12734 (AD-641406) EFFECT OF TRANSISTOR DESIGN PARAMETERS ON RADIATION RESPONSE (POWER TRANSISTORS). Final Report No. 4, July 1, 1965–June 30, 1966. Honnold, V. R.; Thomas, G. D.; Mazenko, J. J. (Hughes Aircraft Co., Fullerton, Calif.). Oct. 1966. Contract DA-28-043-AMC-01541(E). 84p. (ECOM-01541-F). CFSTI $3.00 cy, $0.65 mn.

An investigation of design effects on the radiation resistance of a silicon planar power transistor is presented. A joint theoretical and experimental study of methods was made to modify existing fabrication techniques to produce a power transistor which would minimize the deleterious effects of transient ionizing and displacement producing radiation. The theoretical model was developed by combining a one dimensional base transport equation with the appropriate corrections for high level injection effects. The resulting radiation design equation expresses the radiation resistance of the transistor in terms of the fundamental design parameters which were studied experimentally. The critical physical design parameters were varied in a statistically designed experiment to determine the optimum combination of processing techniques which would maximize the radiation resistance while preserving the useful electrical characteristics of the device. On the basis of these results, the optimum design parameters and processing techniques were combined to evaluate a prototype radiation resistant transistor. (auth)

12735 (AD-641642) TECHNOLOGY, DESIGN, AND APPLICATION OF INTEGRATED CIRCUITS. (Army Electronics Command, Fort Monmouth, N. J.). Aug. 1966. 71p. (ECOM-2747). CFSTI $3.00 cy, $0.65 mn.

The radioinduced behavior of tantalum oxide, mica, ceramic, Mylar, glass, and polystyrene capacitors are described using results obtained at several sources. Also included are discussions on: experimental techniques at each radiation source, including measurement of circuits, components, dosimetry, and variation of circuit and radiation parameters; results from SPRF, LINAC, and AFXR tests describing the dependences of the induced current for the irradiated dielectric; interpretation of these results in terms of appropriate models and radiation and circuit parameters; comparison of the effects observed at each irradiation source; and description of the tests on magnetics and the test results. (auth)

12736 (N-66-19665) AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS. Semiannual Status Report, July 1–December 31, 1965. Compton, W. Dale (Illinois Univ., Urbana. Dept. of Physics). 21p. (NASA-CR-70725). CFSTI $3.00 cy, $0.65 mn.

Changes in the minority carrier lifetimes of silicon resulting from irradiation with ^{60}Co gamma rays were determined. The optical recombination luminescence was studied in silicon following irradiation with ^{60}Co gamma rays or fast neutrons. The thermal stability of defects introduced in highly doped germanium by fast neutron irradiation was investigated. Studies were initiated to determine the properties of highly doped silicon and germanium using the tunneling of electrons between a superconductor and the semiconductor as a tool for measuring the density of states of the semiconductor. (STAR)

12737 (N-66-24404) A STUDY OF THE RELIABILITY OF ELECTRONIC COMPONENTS IN A NUCLEAR-RADIATION ENVIRONMENT. Quarterly Progress Report No. 13, January 1–March 31, 1966. Hamman, Donald J. (Battelle Memorial Inst., Columbus, Ohio). Apr. 15, 1966. Contracts NAS7-100; JPL-950458. 10p. (NASA-CR-74631). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

Environmental tests were completed and final measurements on electronic components exposed to a total of 9633 hours of radiation are reported for test groups III, V, and VI. Component parts in all tests had received about 11,744 hours of operational load, in addition to 100 hours of operation and high flux radiation exposure of the parts in test group IV. Tables that summarize the radiation exposure of test groups III, V, and VI through 9633.0 hours to neutron and gamma irradiation, and show the recorded failures of the transistors are included. (STAR)

12738 (N-66-24959) RADIATION DAMAGE TO SEMICONDUCTORS BY HIGH-ENERGY ELECTRON AND PROTON RADIATION. Progress Report, September 15, 1965–March 15, 1966. Corelli, John C.; (and others) (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1966]. 33p. (NASA-CR-74734). CFSTI $3.00 cy, $0.65 mn.

Summaries are given for studies on: 1.8, 3.3, and 3.9μ radiation induced defect bands in silicon; defects induced in 6 to 88 MeV electron irradiated n-type germanium; effects of phosphorus concentration on the radio-induced 1.8μ band in silicon; and photoconductivity in ≈45 MeV electron irradiated silicon. Infrared spectroscopy was used to identify the 1.8, 3.3, and 3.9μ defect absorption bands in silicon as being due to the divacancy defect. The silicon samples were oriented and irradiated either with 45

MeV electrons or fast neutrons. Radiation damage induced in n-type germanium was studied by means of electrical properties are carrier lifetime measurements. A comparison of arsenic and antimony-doped samples was made to check the effect of the impurity type and concentration. The effects of phosphorus and arsenic concentration on the production and annealing of the divacancy defect, as detected by the 1.8μ radio-induced band, was found to be important. Results on the use of a vacuum infrared monochromator for photoconductivity studies are given; and the high resolution of the instrument and the apparent lack of water vapor or CO_2 background absorption in the photoconductivity spectrum were demonstrated. (STAR)

12739 (N-66-24989) RADIATION EFFECTS ON SILICON SOLAR CELLS. Technical Summary Report, May 16-October 15, 1963. van Lint, V. A. J.; Harrity, J. W.; Nichols, D. K.; Snowden, D. P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 4, 1963. Contract NAS7-91. 56p. (NASA-CR-74712; GA-4797). CFSTI $3.00 cy, $0.65 mn.

Measurements were made of excess carrier recombination in semiconductor samples over a range of carrier concentrations varying between 10^2 and 10^{-4} times the equilibrium majority carrier concentration. Excess carrier lifetime was measured as a function of excess carrier concentration both before and after irradiation in 7 ohm-cm n-type silicon and in 7 ohm-cm p-type samples. Measurements by electron spin resonance (ESR) techniques were made on the rate of production of A centers in silicon as a function of electron energy. A search was made by ESR techniques for other dominant resonance lines, particularly those which might be associated with the predominant recombination center. A reanalysis was made of previously generated data on rate of change of mobility with irradiation to determine the net rate of introduction of ionized impurity centers. A theoretical investigation was made of the statistics of electron-hole recombination for a single defect having two energy levels such that the second one is available only if the first one is already occupied. (STAR)

12740 (N-66-25000) THEORETICAL AND EXPERIMENTAL STUDIES OF RADIATION-INDUCED DAMAGE TO SEMICONDUCTOR SURFACES AND THE EFFECTS OF THIS DAMAGE ON SEMICONDUCTOR DEVICE PERFORMANCE. Semiannual Progress Report No. 4, September 1, 1965-February 28, 1966. (North Carolina State Univ., Raleigh. Semiconductor Device Lab.). [1966]. 44p. (NASA-CR-74733; SDL-4-588-1). CFSTI $3.00 cy, $0.65 mn.

Accomplishments are presented in related projects dealing with surface recombination velocity investigations, surface studies of metal oxide semiconductor capacitors, the measurement of surface recombination velocity as a function of surface potential, and deep lying centers in germanium. Relative to the surface recombination investigations, emphasis is placed on determining the effects of ^{60}Co gamma irradiation (approximately 1.3 MeV) on both the bulk and surface properties of silicon. In the surface studies, progress is reported in examining silicon surface state density changes induced by gamma radiation. The surface potential area presents experimental determinations of the effects of surface potential on the surface recombination velocity of an oxide-silicon surface and its variation with gamma radiation. The studies concerned with deep lying centers in germanium emphasize both theoretical and experimental lifetime variation effects in diodes. (STAR)

12741 (N-66-26760) STUDY OF THE EFFECT OF SPACE RADIATION ON SILICON INTEGRATED MICROCIRCUITS. VOLUME II. Final Report, June 26, 1964-September 26, 1965. (Battelle Memorial Inst., Columbus, Ohio). Contract NAS5-3985. 331p. (NASA-CR-72216). CFSTI $3.00 cy, $0.65 mn.

Schematic diagrams and information concerning the procedures used in monitoring the behavior of silicon integrated circuits during exposure to an electron radiation environment are presented. Configurations are given for both static and dynamic radiation circuits, and load boxes under various radiation conditions. Data sheets listing the pre- and post-irradiation measurements for specific tests and circuit types are given. Also included are figures showing the variation of an output logic level as a function of electron fluence and monitoring curves for the dynamically operated devices. (STAR)

12742 (N-66-34704) STUDY TO INVESTIGATE THE EFFECTS OF IONIZING RADIATION ON TRANSISTOR SURFACES. Third Quarterly Report, March 31, 1966. Report 3434. Sweet, Richard J.; Nelson, David L. (Bendix Corp., Southfield, Mich. Research Labs. Div.). May 1966. Contract NAS8-20135. 41p. (NASA-CR-77360). CFSTI $3.00 cy, $0.65 mn.

A summary is presented of the results from a program conducted to delineate the effects of ionizing radiation on transistor surfaces. The areas of investigation included electrical bias effects, time-dose relationships, recovery effects, temperature-ionization relationships, and irradiation of evacuated devices. The tests conducted are described briefly, and tables and graphs which summarize the data obtained are provided. It is stated that the methods producing the effects were characterized, models which describe the physical phenomena were established, nondestructive screening techniques for separating transistors with good immunity from those with poor immunity were developed, and surface treatments or manufacturing processes which may lead to a minimum of ionizing radiation surface effects were evaluated. (STAR)

12743 (N-66-37545) STUDY TO INVESTIGATE THE EFFECTS OF IONIZING RADIATION ON TRANSISTOR SURFACES. Quarterly Report No. 4 [for] Period Ending June 30, 1966. Sweet, Richard J.; Nelson, David L. (Bendix Corp., Southfield, Mich. Research Labs. Div.). July 15, 1966. Contract NAS8-20135. 54p. (NASA-CR-78352). CFSTI $3.00 cy, $0.65 mn.

An investigation was made of the effects of ionizing radiation on transistor I_{CBO} and h_{FE} with measuring conditions and electrical bias during irradiation as variables. Two current components were identified that affect I_{CBO} and h_{FE} at low levels: surface channel current and surface space charge region recombination-generation current. To explain variations in both h_{FE} and I_{CBO} for both n-p-n and p-n-p transistors, a model was proposed, which includes the effects of bias during irradiation. Based on test results and the model, a procedure was devised consisting of an irradiation screening test followed by temperature annealing, which enables selection of transistor types and individual transistors that are least sensitive to ionizing radiation. (STAR)

12744 (N-66-37676) DAMAGE TO FIELD-EFFECT TRANSISTORS UNDER 22 AND 128 MeV PROTON BOMBARDMENTS. Bryant, Floyd R.; Fales, Carl L. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Oct. 1966. 45p. (NASA-TN-D-3630). CFSTI $3.00 cy, $0.65 mn.

Silicon n- and p-channel planar diffused junction, silicon n-channel epitaxially grown junction, and germanium n-channel alloy junction field effect transistors were irradiated with 22 and 128 MeV protons. Transistor curve tracer photographs of the drain characteristic curves were obtained at various integrated proton flux levels and several electrical parameters were determined. Simple theory from a model based on initial carrier removal rate indicates a linear and quadratic dependence of zero gate transconductance and drain current on integrated proton flux, respectively. Two of three transistors studied possessed zero gate transconductance variations in reasonable accord with the anticipated first degree dependence. In contrast, the curves of zero gate drain current as a function of flux of the third type adapt well to a straight line fit. The quadratic dependence of the zero gate voltage drain current fails, but a power law relation with proton flux holds and the exponents range from 1 to 1.6. Accurate radiation damage prediction for the transistors is not easily obtained because of the initial spread in their irradiation responses. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 12299, 12301, 12315, 12834, 12927, 12942, 12946, 12951, 12953, 12969, 12977, 13020, 13064, 13072, 13074, 13086, 13351, 13352, and 13363.

12745 (ANL-7217) HEALTH DIVISION GAMMA-RAY SPECTROSCOPY GROUP ANNUAL REPORT, JULY 1964 TO JUNE 1965. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 147p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radium retention data were analyzed in detail for a small series of eight patients who received known amounts of ^{226}Ra by weekly intravenous injection in 1931 and who have been measured in a whole-body counter in recent years. When individual power function parameters were computed for each patient, the slopes ranged from -0.191 to -0.634 and the one-day intercepts from 0.029 to 0.977. These parameters are highly correlated ($r = 0.83$) so that the power function does not have two independent parameters. Although the parameters for the average power function can be computed in several ways, a reasonable set of mean values gives a slope of -0.4383 and a one-day intercept of 0.3015. The same data starting one year after injection can be fitted equally well if not better with a single exponential term so that retention after one year decreases with a half-time of 14.98 years. About 2.5% of the administered radium disappears from the body in accordance with this single exponential term, 97.5% having been eliminated within the first year. Retrospective estimates of the maximum radium body burden, which occurred immediately after the last injection of 10 μCi, were computed on the basis of the best-fitting power function for each patient. Although the patients received total amounts ranging from 150 to 300 μCi, the estimates of maximum body radium ranged from 17.6 to 27.8 μCi. The relative merits of the power function and the single exponential function for describing radium retention patterns are discussed in light of the data and the analyses. (auth)

12746 (CONF-651008-, pp 94-125) UPTAKE OF RADIOACTIVITY BY VEGETATION AS A RESULT OF SOIL AND FOLIAR CONTAMINATION. Gabay, J. J.; Dapolito, J. A.; Sax, N. I. (New York State Dept. of Health, Albany).

The mode of uptake of 10 radioisotopes by 5 vegetables used directly in the human food chain was studied after soil or foliar application and under two types of soil conditions. The isotopes included $^{144}Ce-^{144}Pr$, ^{131}I, ^{125}Sb, $^{106}Ru-^{106}Rh$, ^{85}Sr, ^{137}Cs, and $^{95}Zr-^{95}Nb$. The vegetables included beans, both Tender Green and Pencil Pod Black Wax varieties of Fabaceae; corn, both Golden Beauty Sweet and DeKalb No. 224 Field varieties of Cornacea; lettuce, Black Seeded Simpson variety of Cichoriaceae; potatoes, Irish Cobbler variety of Solanaceae; and tomatoes, Glamour variety of Solanaceae. The soil was basically a sandy loam. One plot had not been fertilized or cultivated for several years and the other plot had been cultivated and had been previously fertilized with cow manure and lime. Data are tabulated and the effect of variables, such as time application, harvest time, and rainfall are discussed. Results indicated that foliar deposition is the predominant mechanism for radionuclide uptake by the vegetables studied. The plants grown on fertilized plots all showed less uptake of radionuclides per unit weight of sample than did plants grown on unfertilized plots. (C.H.)

12747 (CONF-651008-, pp 126-33) ^{226}Ra IN INFANT DIET AND BONE. Harley, N. H.; Harley, J. H.; Fisenne, I. M. (New York Operations Office (AEC), N. Y.).

A number of bone specimens from infants were analyzed for ^{226}Ra. The results indicate that the levels are the same as found in adults from the same locations. Since the diet levels are shown to be lower in radium and higher in calcium than those for adults, the infant must have a lesser discrimination against radium compared to calcium. The fact that the same level is found in stillborns would support the hypothesis that the mother's metabolic pool of calcium has the same radium concentration as her bone. (C.H.)

12748 (CONF-651008-, pp 143-6) URINARY EXCRETION OF ^{35}S SULFANILIC ACID FOLLOWING INHALATION EXPOSURE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Sandia Corp., Albuquerque, N. Mex.).

Five individuals who participated in an experiment involving the injection of millicurie amounts of ^{35}S-sulfanilic acid into rabbits submitted 24-hr samples of urine on the day before the first injection of the animals and for 3 days after a series of injections repeated after 8 and 24 days. The urine samples were analyzed for ^{35}S. High values of ^{35}S were found in urine samples collected on the 21st day after the first exposure and the sample collected between the 38th and 74th days showed no activity. It was assumed that the exposure of these individuals was due to inhalation and that the appearance of ^{35}S-sulfanilic acid from the gastrointestinal tract following its expulsion from the lungs. (C.H.)

12749 (NYO-3086-6) RADIOACTIVITY STUDIES. Annual Progress Report, December 1, 1965-November 30, 1966. Eisenbud, Merril; Petrow, Henry G. (New York Univ., N. Y. Inst. of Environmental Medicine). Oct. 1, 1966. Contract AT(30-1)-3086. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on estimates of the body burden of Ra in individuals exposed while employed as luminous dial painters. The effective half-life of ^{226}Ra in man, calculated from ^{214}Bi retention data, was found to be approximately 11 yr. Data are included from whole-body counting of the content of ^{226}Ra decay products in man and the Rn content in the breath of these individuals. Data are included from measurements of the content of ^{226}Ra, ^{228}Ra, ^{210}Pb, and ^{228}Th in bone and soft tissues of dial painters. Procedures are described for the spectrophotometric determination of Th in bone ash, the atomic absorption spectrometric determination of Pb in bone ash, and the spectrographic determination of Th, ^{210}Pb, ^{228}Th, ^{228}Ra, and ^{226}Ra in bone or plant ash. The distribution of ^{228}Th, ^{212}Pb, and ^{212}Bi in the tissues of rats after inhalation of ^{220}Rn was measured. Results are included from a study of possible mechanisms involved in the apparent concentration of ^{226}Ra and ^{210}Pb in the aorta and thyroid of radium dial painters. Statistical methods used for determining the biological half-life of ^{226}Ra in man are described. Design features of a ^{220}Rn atmosphere exposure chamber for rats are described. (C.H.)

12750 (STI-DOC-10/60) LABORATORY TRAINING MANUAL ON THE USE OF ISOTOPES AND RADIATION IN ANIMAL RESEARCH. Technical Reports Series No. 60. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 196p. IAEA $4.00; S 84,-; Pound 1.4,0; F Fr 16,-; DM 14,-.

This manual contains lecture material and laboratory exercises applicable to a basic course on the use of isotopes and radiation in animal research. Basic concepts of nuclear physics, radiation detection, and health physics are discussed and applications of the basic principles are discussed. Eighteen laboratory exercises are given to illustrate the use of various radiation detection instruments; 13 others cover tracer studies in rats, dogs, and frogs; and one shows the acute effects of radiation on rats. The material is well organized and each section is followed by a bibliography. The appendixes present information pertinent to the studies. (C.H.)

12751 (TID-23456) THE RESPONSE OF THE RESPIRATORY TRACT AND LUNG TO INHALED STABLE AND RADIOACTIVE ISOTOPES OF CERTAIN ELEMENTS. Final Report, April 15, 1962-April 14, 1966. Berke, Harry L.; Vorwald, Arthur J. (Wayne State Univ., Detroit, Mich. Dept. of Occupational and Environmental Health). Nov. 1, 1966. Contract AT(11-1)-1181. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies on the distribution of inhaled radioactive aerosols of rare earth compounds in rats and dogs and the responses evoked by the deposited radioisotopes. Results are included from studies on the metabolism of inhaled or intratracheally administered aerosols of $^{152-154}EuCl_3$ in rats; the long-term response of rats to inhaled aerosols of $^{152-154}EuCl_3$, with emphasis on the relationship between the radiological dose delivered to the lung or to the whole-body and the pathological response; and the metabolism of stable $EuCl_3$ following the intratracheal administration of solutions in dogs. Results are also included from a study on the effects of various doses of x radiation on the size of lymphocytes in rats. The design of a double-walled inhalation chamber attached to animal housing quarters, the design of an aerosol generator, and the design of an aerosol sample are described. Schematic sketches are included. (C.H.)

12752 (TID-23508) EFFECT OF IRRADIATED GLUCOSE ON MITOTIC CHROMOSOMES. Final Report. Ma, Te Hsiu (Western Illinois Univ., Macomb. Dept. of Biological Sciences). 1966. Contract AT(11-1)-1563. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The lateral roots of Vicia faba were treated with γ irradiated glucose solutions of various dilutions and age for periods of 1, 2, or 3 hr followed by 3 hr of colchicine treatment before fixation and the preparation of squash microslides. The percentage of breaks per 100 cells was counted in metaphase chromosomes.

No clear distinction was noted between the effects of short-lived unstable products and long-lived products of radiolysis of the glucose solutions, although aged solution (92 hr post-irradiation) produced a higher rate of breakage than the other groups. A delay in the mitotic cycle corresponding to the duration of treatment was observed. (C.H.)

12753 (UCRL-16898, pp 1-10) ENDOGENOUS PRODUCTION OF ^{14}CO: AN IN VIVO TECHNIQUE FOR THE STUDY OF HEME CATABOLISM. Landaw, Stephen A.; Winchell, H. Saul (California Univ., Berkeley. Lawrence Radiation Lab.).

A method is presented for the separation, detection, and quantitation of endogenously produced carbon-14-labeled carbon monoxide in the rat, following injection of glycine-2-^{14}C. In this method, respiratory $^{14}CO_2$, the only significant breath contaminant, is removed with a sodalime absorber. The remaining breath activity, due primarily, if not entirely, to ^{14}CO, is oxidized to $^{14}CO_2$ by Hopcalite, absorbed in an ethanolamine-containing solution, and counted by liquid scintillation. Standard ^{14}CO and $^{14}CO_2$ gases, as well as animal experimentation, confirm this method's ability to measure ^{14}CO and $^{14}CO_2$ production rates simultaneously, following a single injection of labelled glycine. Examples are given to show that this continuous, in vivo, and easily performed method can give important information concerning heme catabolism. The technique should provide a unique source of information in the study of disease processes characterized by abnormal heme catabolism in man and other animals. (auth)

12754 (UCRL-50007-66-1, pp 37-40) ^{65}Zn CONTENT IN 90-IN. CYCLOTRON WORKERS AT LIVERMORE. Anderson, A. L.; Schmidt, C. T. (California Univ., Livermore. Lawrence Radiation Lab.).

The presence of ^{65}Zn in cyclotron operators and related support group personnel was detected as a result of routine measurements using a whole-body counter. Scans on 16 people revealed internal deposition of ^{65}Zn ranging from 2 to 850 nCi. A differential scan on one man indicated that the primary mode of entry into the body is inhalation and that the initial activity assumes a uniform distribution throughout the body. (C.H.)

12755 ABSORPTION OF ^{64}Cu IN THE SHEEP AND RAT. INFLUENCE OF ELEVATED DOSES OF IRON AND MOLYBDENUM. INTERFERENCE WITH METABOLISM OF PHOSPHORUS. Hennaux, L.; Burny, A.; Nangniot, P.; Mommer, R.; Roderbourg, J.; Vanuytrecht, S. (Faculte des Sciences Agronomiques de l'Etat, Gembloux, Belg.). Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 449-62(1963). (In French).

Male castrate sheep were given 5 mC ^{64}Cu intragastrically and fecal elimination of the radioisotope was followed for 15 days and renal excretion for 4 hr. Some sheep were given a 12.5 g per day supplement of reduced iron. Renal excretion of ^{64}Cu was similar in the two groups the first three hr; in the 4th hr the excretion was higher in the group given iron (940 vs 810 cpm). The fecal excretion of ^{64}Cu was similar in the two groups except on the second day, when it was higher in the iron-supplemented group (142 vs 128 cpm). However, it is concluded that very high doses of iron do not appreciably alter ^{64}Cu retention in the sheep. The tissue distribution of ^{64}Cu was studied in rats 2, 4, and 6 hr after intragastric administration, with and without supplements of reduced iron. The ^{64}Cu levels in blood were increased by Fe, but its entrance into liver was delayed by giving iron. Excretion and tissue uptake of ^{32}P was also studied in rats. Some received dietary additions of Mo (1000 ppM) or Mo + Cu (1000 and 200 ppM, respectively). Tissue uptake of ^{32}P was improved by Mo, and it is postulated that phosphorus metabolism is thereby improved. (BBB)

12756 MULTIPLICITY REACTIVATION AND RADIATION SURVIVAL OF AGGREGATED VACCINIA VIRUS. CALCULATION OF PLAQUE TITER BASED ON MR AND PARTICLE AGGREGATION SEEN IN THE ELECTRON MICROSCOPE. Sharp, D. G.; Kim, K. S. (Univ. of North Carolina, Chapel Hill). Virology, 29: 359-66(July 1966).

Attempts were made to extend the concepts, proposed for multiplicity reactivation (MR) in the bacteriophages, to the vaccinia virus-L cell system. It was found that the survival of plaque-forming units of vaccinia virus after uv irradiation is strongly dependent upon aggregation among the particles at the time of titration. Enhanced survival was shown to be closely correlated with the degree of aggregation observed in virus samples sedimented directly for observation in the electron microscope. This enhancement is attributed to MR. The data provide a means of testing the concept that there are a limited number, n, of critical points in the viral DNA that are subject to random photon damage. An expression was derived for the plaque titer as a function of n, of the observed degree of particle aggregation, and the fraction of the particles that produced plaques before irradiation. A computer test of this function revealed that $n = 5$ for the virus gives an excellent fit with survival data from preparations differing widely in aggregation. All the virus particles appear to be functional in reactivating the damaged plaque-forming particles. (BBB)

12757 DETERMINATION OF EVAPOTRANSPIRATION USING THE NEUTRON-SCATTERING METHOD. Bowman, D. H.; King, K. M. (Ontario Agricultural Coll., Guelph). Can. J. Soil Sci., 45: 117-26(June 1965).

An evaluation was made of the measurement of evapotranspiration (ET) by the neutron-scattering method under certain field conditions, its accuracy, and limits of its application. A Nuclear Chicago P-19 depth probe, P-21 surface probe, and 2800 scaler were used to measure the soil moisture. Measurements were taken weekly from June to September in unirrigated and irrigated corn and wheat seeded with clover. It is concluded that the neutron scattering method described is an easy and satisfactory means of estimating the ET of crops growing in undisturbed soil. The method was found accurate to 0.15 in. of water for 1 week, or 0.62 in. over a 3-month period, using only one site in a gravelly soil. The error is reduced considerably, however, by averaging over several sites and by measuring the percolation or capillary rise more carefully, using the technique suggested. The accuracy gained by taking readings longer than 2 min at each soil depth is small, however, in view of the non-uniform moisture distribution within the soil. Application of this method to other soils and conditions appears feasible. Careful attention to the effects of surface flow, percolation, capillary rise, lateral movement, deep-rooted plants as well as instrument calibration is essential to accurate determinations of ET by the neutron-scattering method. (BBB)

12758 EXPERIMENTAL STUDY ON THE LOCALIZATION OF ^{58}Co IN THE RAT. Blanquet, P.; Dervillee, P.; Dervillee, Et.; Segalen, D. Arch. Mal. Prof. Med. Trav. Securite Soc., 26: 235-8(Apr.-May 1965). (In French).

Distribution of ^{58}Co was studied in two groups of rats. In the first group an intraperitoneal dose of 200 μC ^{58}Co was given and the animals were sacrificed two weeks later. In the second group, rats were given a daily oral dose of 50 mg/kg $CoCl_2$ for 15 days. On the eighth day, 200 μC ^{58}Co was injected and the rats were sacrificed on the 15th day. The results showed that ^{58}Co levels fell most rapidly in kidney and liver, and it is possible that ^{58}Co was preferentially eliminated via these organs. In the early phase, ^{58}Co excretion in the urine was very high. Myocardium accumulated relatively high levels of ^{58}Co, and this may be related to the depression of cardiac activity by Co salts and the accompanying interstitial edema and hyaline degeneration of myocardial fibers. Relatively low levels of ^{58}Co were found in lung, bone, muscle, and testis. The ^{58}Co concentration in various tissues was markedly decreased after preliminary doses of stable Co. (BBB)

12759 TRANSPORT OF CATIONS BY RABBIT GALL BLADDER: EVIDENCE SUGGESTING A COMMON CATION PUMP. Peters, Clarence J.; Walser, Mackenzie (Johns Hopkins Univ., Baltimore). Amer. J. Physiol., 210: 677-83(Apr. 1966).

Passage of ^{85}Sr, ^{86}Rb, ^{137}Cs, and other cations across the gall bladder was studied in vitro with everted bladder placed in oxygenated solutions of the ions. After 0.5 to 8 hr, the fluid which appeared within the everted sac was sampled. In the presence of reasonably normal cation concentrations (except for Li 4 mM) and 0 to 120 mM sucrose, all 8 cations tested appeared in the fluid at serosal/mucosal ratios which increased in parallel with increasing sucrose addition. Cations with crystal radii larger or smaller than Na exhibited ratios lower than Na. When five-eighths of the Na was replaced by any one of the other cations, the fluids elaborated contained as much of the substituted cation as of Na. Some transport persisted in the virtual absence of Na. The results favor a common cation transport mechanism, although passive movement in response to sodium transport, or independent mechanisms for each of the 7 other ions tested cannot be excluded. Arrangement in sequence of increasing crystal radius, lead to the following sequential differences: $Li > Mg < Ca < Sr < K < Rb < Cs$. Thus, with the exception of Li, a progressive increase was seen with increasing crystal radius. No explanation was offered for these suggestive relations between ion transport rates and unhydrated ion size. (BBB)

12760 LOCALIZATION OF LIGHT-INDUCED STRONTIUM ACCUMULATION IN SPINACH CHLOROPLASTS. Nobel, Park S.; Murakami, Satoru; Takamiya, Atusi (Tokyo Univ.). Plant Cell Physiol., 7: 263-75(1966).

The uptake of ^{85}Sr by chloroplasts was investigated and electron-microscopic evidence showing the location of Sr and Ca deposits on the lamellae of chloroplasts is presented. The chloroplast limiting membrane did not act as a barrier to Sr ion accumulation, since the chloroplasts were ruptured during the isolation and incubation, especially in the light. The grana stacks also were exten-

sively swollen. The number of electron-dense deposits (Sr) attached on the lamellae was greatly increased by light under conditions favoring the hydrolysis of ATP. The average diameter of the deposits after a 6-min illumination and incubation with 1 mM $SrCl_3$ was 14 mμ, after 15 min with 1 mM $SrCl_2$ was 21 mμ, and after 15 min with 20 μM $SrCl_2$ was 13 mμ. The findings were in agreement with the results of ion-uptake experiments using radiostrontium and radiocalcium. (BBB)

12761 ABSORPTION OF CESIUM BY BARLEY: INFLUENCE OF ITS RETENTION IN THE SOIL, COMPETITIVE ACTION OF POTASSIUM. Ferron, Francoise (Centre National de Recherche Agronomique, Versailles, France). Ann. Physiol. Veg., 91-117 (1964). (In French).

Absorption of ^{137}Cs by barley was examined in view of the fallout contamination of the plant by this long-lived fission product, to examine the relation of its uptake from the soil as affected by the stable cesium and postasium content of the soil. With plants cultivated for 6 days in nutrient solutions containing ^{137}Cs and stable Cs, the uptake of ^{137}Cs showed little variation as the concentration of Cs was increased. In 21-day soil cultures, barley plants absorbed only a small amount of ^{137}Cs. When the percentage of stable Cs was low, the fraction of ^{137}Cs absorbed increased sharply as the percentage of stable Cs reached a certain threshold value. This was observed when Cs did not exceed 2% of the soil exchange capacity. In liquid media, addition of increasing amounts of K markedly inhibited ^{137}Cs uptake by barley plants, up to about 3.3% K (percentage of total cations in the solution). Addition of K to the soil used, already relatively high in K, only slightly decreased ^{137}Cs uptake by barley. It is suggested that barley shows increased selectivity for Cs as the Cs/K ratio decreases. These experiments revealed the divergent results obtained between liquid and soil cultures of radiocesium incorporation by barley plants. (BBB)

12762 LOCALIZATION OF NEW CELL FORMATION IN TENDON HEALING BY TRITIATED THYMIDINE AUTORADIOGRAPHY. Dodd, Rosalie M.; Sigel, Bernard; Dunn, Marvin R. (Women's Medical Coll., Philadelphia). Surg. Gynecol. Obstet., 122: 805-6(Apr. 1966).

A radioisotope method was developed to explore the site of fibroblast origin in tendon repair. The use of tritiated thymidine autoradiography to identify cells synthesizing DNA aided in the identification of newly formed cells because the nuclei of cells just prior and after division are clearly marked. In both the young and adult rats with severed Achilles tendons, labeled fibroblastic mesenchymal cells first appeared in the tendon sheath and surrounding tissue on the first day. The labeled cells in the tissue adjacent to the tendon arose mainly from the adventitia of blood vessels. On the succeeding 2 days, as more labeled cells appeared in the vicinity of the cut tendon, fewer of these marked mesenchymal cells could be found in the blood vessel adventitia. At 2 days after wounding, labeled mesenchymal cells appeared within the tendon. The results confirmed earlier conclusions that fibroblasts in tendon regeneration originate in the tendon sheath, surrounding tissue, and, after a lag period, from within the tendon itself. More specifically, however, the results showed that most of the fibroblastic mesenchymal cells were derived from blood vessels. (BBB)

12763 EFFECTS OF X-RAY IRRADIATION ON THE LIPID PEROXIDATION AND SWELLING OF MITOCHONDRIA INDUCED BY FERROUS IONS. Utsumi, Kozo; Yamamoto, Goki (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 345-50(July 1966).

Effects of x ray irradiation on the lipid peroxidation and swelling of the mitochondria of whole body irradiated rat liver were studied by measuring the oxidative phosphorylation, lipid peroxidation, 90° lightscattering or absorption at 520 mμ after addition of Fe^{++} and obtained the following results. The mitochondrial swelling induced by Fe^{++} is caused by the formation of lipid peroxide which is formed at a certain lag period after addition of certain concentration of Fe^{++}. The activity of oxidative phosphorylation and respiratory control of mitochondria was reduced by 80 per cent after x ray irradiation for 6 hours, which returned to normal after 12-17 hours. The lag period for the formation of lipid peroxide after addition of Fe^{++} was shortened remarkably with x ray irradiation for 22 hours, which returned to normal after 48 hours. In the mitochondria isolated from rat liver after x ray irradiation for 24 hours, a remarkable decrease was observed in the content of unsaturated high fatty acids in comparison with that of nonirradiated liver. (auth)

12764 PRESERVATION OF VIABILITY OF FROZEN HUMAN BONE MARROW. Pyle, H. M. (Protein Foundation, Jamaica Plain, Mass.). Bibl. Haematol., 23: Pt. 3, 652-5(1965).

Viability of frozen bone marrow was determined by incorporation of ^{3}H-thymidine and subsequent autoradiography. Preservation was accomplished by mixing equal volumes of freshly collected bone marrow into preservation media containing 20% dimethyl sulfoxide (DMSO). This preparation was frozen in a −80° mechanically refrigerated box. By careful handling and storage in small aliquots, viability of the frozen marrow was comparable to fresh marrow. Bone marrow stored up to one year showed similar viability; however, with longer periods of storage, viability tended to fall. DMSO is toxic to the cells, but after washing the viability returns toward normal. Above 50% DMSO concentration there is irreversible damage to the viability. However, if fresh red cells in serum were added to frozen thawed marrow, incorporation of ^{3}H-thymidine returned almost to normal. The beneficial effect of red cells probably represents a transfer of ATP from the red cell membrane to the thawed cells. Metabolic activity of resting bone marrow as measured by ^{3}H-thymidine incorporation, varied from 4 to 13%. Acute leukemia and idiopathic thrombocytopenia marrow showed an incorporation of ^{3}H-thymidine of 12 to 16% and untreated pernicious anemia marrow between 36 and 55% (percentage of cells with ^{3}H-thymidine granules). (TSS)

12765 PRESENT PERSPECTIVES ON THE BIOLOGICAL EFFECTS OF NON-IONIZING RADIATIONS. Benezech, C. Arch. Mal. Prof. Med. Trav. Securite Soc., 26: 631-40(Dec. 1965). (In French).

Fundamental problems in the mechanism of action of nonionizing radiations (mainly uv) are reviewed. Knowledge in this area of photobiology is only fragmentary, but two basic concepts predominate. Firstly, the action spectra of the radiations seem to correspond, in general, with the absorption spectra of the biologic material acted upon. This is shown most clearly with nucleic acids and other well-defined substances. Secondly, the formation of free radicals, particularly from water, helps explain many of the products obtained. The mutagenic effect of uv radiation, as well as its effect on enzymes, other proteins, and nucleic acids, is examined. Small molecules may undergo oxidation, deamination, or hydrolysis upon uv irradiation. Photolysis of water, with formation of H' and HO' radicals, and subsequent reaction of the radicals with other molecules, can be used to interpret many reactions. However, it is often difficult to determine whether these secondary reactions or the primary action of radiation on the structures in question is most important. (BBB)

12766 RADIOAUTOGRAPHIC STUDY BY ELECTRON MICROSCOPY OF ^{131}I IN THE THYROID OF THE RAT. Lupulesco, A.; Petrovici, A. (Inst. of Endocrinology, Bucharest). Arch. Anat. Microscop. Morphol. Exp., 54: 895-902(July-Sept. 1965). (In French).

High resolution radioautography was used for localization of ^{131}I 6 hr after injection of 0.8 mC of the radioisotope in adult rats. At this time a massive accumulation of ^{131}I in the colloid could be detected. It was present to a lesser degree in the adjacent apical vesicles, in the ergastoplasmic sacs, in the secretion granules of the golgi zone, and the interior of the nucleus. Radioiodine was absent from the basal zone of the follicular cells. Radioiodine could also be found in the nucleus and in the double nuclear membrane. It is believed that localization in these sites represents metabolic steps in the organification of ^{131}I, rather than being attributed to artefacts. The findings are interpreted as showing that iodination of thyroglobulin occurs in the follicular colloid and by a process of resorption migrates into the thyroid cells. (BBB)

12767 LABELLING MOSQUITOES WITH RADIOACTIVE IODINE, ^{131}I. Garby, L.; Yasuno, M.; Phurivethaya, Y. (Univ. of Medical Sciences, Bangkok). Trans. Roy. Soc. Trop. Med. Hyg., 60: 136(1966).

To label insects for studies of their flight range and dispersal rates, ^{32}P, a β emitter, has been most commonly employed, but its detection in insects is time-consuming and complicated. A method was for use of ^{131}I, a γ emitter, for labeling Culex pipiens fatigans, a common household mosquito in many tropical countries. In preliminary studies, the larvae were reared in water containing Na ^{131}I in tracer amounts. As the larvae grew, their uptake of iodine increased steadily. When 50 μC of Na ^{131}I were added to 4 liters of water containing 1000 larvae, the last instar larvae contained about 100 cpm per individual as measured in a well scintillation counter. The larvae had been exposed for 10 days. However, the level of radioactivity in the pupae dropped to half and the adults, soon after emergence, had only about 20 cpm per individual. The biological half-life in an adult mosquito was about 6 days. In later experiments, adult mosquitoes aged 2 to 3 days were kept in cages and 50 ml of 5% glucose solution containing 200 μC of Na ^{131}I was provided as food. After 4 days the average radioactivity was 10,590 cpm for females and 5980 cpm for males. The amount of radioactivity in the mosquitoes remained nearly constant for 2 days after the solution containing the isotope was

removed. When the radioactive food was provided for only 2 days, the variation in radioactivity among the mosquitoes was larger. After the mosquitoes were dissected, the distribution of radioactivity was as follows: head 11%, thorax 29%, abdomen 18%, legs 37%, and wings 7%. No effects on the mortality and morphology of the mosquitoes were observed. (BBB)

12768 BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. VII. BIOSYNTHESIS OF ALKALOIDS TRIPLY LABELED WITH ^{14}C, ^{3}H, AND ^{15}N. Tso, T. C. (Agricultural Research Service, Beltsville, Md.). Phytochemistry, 5: 287-92(May 1966).

Methods are described for the synthesis of nicotine and other tobacco alkaloids labeled with these three isotopes. Nicotiana rustica var. brasilia plants were grown inside a specially constructed chamber and supplied with $^{14}CO_2$, $^{3}H_2O$, and ^{15}N as nitrate. Despite the fact that the $^{14}CO_2$ activity was only half that of HTO, the incorporation of ^{14}C and ^{3}H, as well as the highest excess ^{15}N, was found in the leaves of the middle part of a plant. In plants of this variety sampled at an actively growing stage, a considerably high percentage of activity was found in alkaloids other than the principal alkaloid (nicotine), including nornicotine, anatabine, and anabasine. From the incorporation of ^{14}C and ^{3}H, a special role of anatabine in the nornicotine-nicotine conversion system is indicated. Generally, the ratios of $^{14}C/^{15}N$, $^{3}H/^{15}N$, and $^{14}C/^{3}H$ in nicotine were found to increase from root to top leaves; this is parallel to the distribution of the amount of nicotine found in these plants. The alkaloids and other labeled materials will be used for further metabolic investigations. (BBB)

12769 FEEDING RATE OF CARP ESTIMATED BY A RADIOISOTOPIC METHOD. Kevern, N. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Fish. Soc., 94: 363-71(Oct. 1966). (ORNL-P-1952).

The feeding rate was estimated for yearling carp living in a small lake contaminated with low-level radioactive wastes. The amount of ^{137}Cs that must be ingested to maintain the equilibrium body burden of the carp was calculated from measured values for body burden, biological elimination rates, and assimilation factors. The radioisotope was ingested by the fish as an integral part of its food items. The amount of food consumed was estimated by measuring the concentration of ^{137}Cs in the food items. An age and growth study and the weight-length relation are given for the carp. The estimate of the average daily food intake was 5.36 g wet weight (3.9% of mean body weight) consisting of 2.4 g detritus and 1.6 g algae for maintenance, and 0.82 g detritus and 0.54 g algae for growth. On an energy basis, 3.7 Kcal was consumed for maintenance and 1.3 Kcal for growth. Net and gross food conversion factors were 3.18 and 12.55, respectively, and the ecological growth efficiency was 0.08. Further study is needed to determine if the method is sensitive enough to reflect variations in metabolism and growth caused by seasonal temperature changes or size differences. (BBB)

12770 LASER EFFECT ON RESISTANCE OF HUMAN DENTAL ENAMEL TO DEMINERALIZATION IN VITRO. Sognnaes, Reidar F.; Stern, Ralph H. (Univ. of California, Los Angeles). J. S. Calif. State Dent. Ass., 33: 328-9(Aug. 1965).

Extracted human teeth with intact enamel were exposed to superficially focused laser beam impacts in localized regions The laser exposures were carried out with a beam duration time of 500 μsec and generally about 12.0 J energy. After immersion in demineralizing solution the teeth were checked daily under a microscope for evidence of changes in surface opacity or incipient chalkiness indicative of partial demineralization. Unlasered control enamel showed typical subsurface demineralization similar to early caries of enamel. By contrast, a superficially lasered enamel surface, exposed to the identical demineralizing conditions, retained a high microdensity with very little mineral leakage from the subsurface area. With more sharply focused laser beams by which minute craters were formed in the enamel, the edges of the craters (which exhibited only superficial laser effects) were compared with adjacent unaltered enamel. In these transitional zones, which could be compared in immediate juxtaposition to each other, the lasered enamel showed little or no demineralization compared to the unlasered enamel. It remains to be determined whether this protective effect is purely physical, rendering enamel more amorphous or causing fusion of microstructures, or whether in addition there are certain chemical reactions in the enamel caused indirectly by the laser beam. (BBB)

12771 PHOTOCHEMISTRY OF NUCLEIC ACIDS AND ITS GENETIC IMPLICATIONS. Shugar, D. (Inst. of Biochemistry and Biophysics, Warsaw). Israel J. Med. Sci., 1: 1347-62(Nov. 1965).

Effects of uv and ionizing radiations on RNA and DNA and their constituents are reviewed. With ionizing radiations the results are complicated by the fact that energy absorption is nonspecific and the energies involved are such that the constituents of a nucleic acid chain are susceptible to a greater or lesser degree. Furthermore, with ionizing radiations, energy absorption occurs uniformly throughout the cell volume, so that components other than nucleic acids are also affected. With uv radiation the situation is considerably simplified by the fact that nucleic acids absorb very strongly in this spectral region by comparison with other cellular constituents. Most effective wavelength for the killing of microorganisms is close to 260 mμ, the wavelength of maximum absorption of both RNA and DNA. It is now well established that most of the effects of uv light are exerted through modifications in the nucleic acids. Furthermore, the natural purines, and their glycosides, found in nucleic acids, are relatively radiation resistant as compared to the pyrimidines, thus providing additional simplification in the search for photochemical modifications. Some photochemical reactions are described which concern photoreactivation. Some photochemical transformations of the pyrimidine components of nucleic acids are also considered. Photohydration of cytosine and its glycosides is dealt with in detail. The behavior of derivatives of 5-fluoro-uracil, which is readily incorporated in place of uracil into the RNA of plant and animal viruses, with an analogous increase in radiation sensitivity, is discussed. It is suggested that if it should prove possible to substitute 5-fluorouracil for uracil in the DNA of phage, this would provide a useful model for an examination of photochemical effects under conditions where thymine dimerization is replaced largely by a hydration reaction. Nucleic acid photochemistry has important biological ramifications, including genetic analysis and sequence studies in nucleic acids; and potential applications to the controlled inactivation of virus infectivity. (BBB)

12772 BONE SALT ACCRETION AND EXCHANGEABLE CALCIUM SPACES IN MAN MEASURED WITH ^{47}Ca AND ^{85}Sr. Wendeberg, Bo. (Univ. of Lund, Sweden). Clin. Orthopaed., 40: 162-83(May-June 1965).

Various models for use of radioisotopes to study exchangeable Sr in the human body were examined, especially the 4-compartment one. Studies with ^{85}Sr have shown that 3 of the 4 exchangeable compartments can be interpreted as consisting largely of extraskeletal strontium or calcium; the exchange among these 3 compartments is very rapid. The 4th more slowly exchangeable compartment was interpreted to represent calcium or strontium of the bone mineral. A 4-compartment model is difficult to use for routine analysis of isotope data obtained in the clinic; therefore, the 3 compartments were lumped into 1 compartment to study the properties of an open 2-compartment model for analysis of strontium and calcium kinetics in man with special emphasis on the skeleton. This analysis was based on serial measurements of blood, urine, and fecal activities following intravenous administration of ^{47}Ca or ^{85}Sr to human subjects with normal or disturbed skeletal metabolism. Scintillation counters located on the body surface were used for measurements of tracer in bone and soft tissues. Each patient received a dose of less than 1 μC per kg body weight by a single intravenous injection. The amount of radiation delivered to the skeleton or to the gonads by this dose was calculated to be less than the maximum permissible dose recommended by the International Commission on Radiological Protection. Methods for calculation of accretion rate, excretory clearance rates, and sizes of the exchangeable calcium or strontium spaces in the body are described. Body distribution of injected ^{47}Ca or ^{85}Sr among the exchangeable compartments and the nonexchangeable fractions of bone mineral during a 10-day postinjection period was calculated. Externally recorded activity curves over the knee and the thigh regions during the period 1-10 days after injection of ^{47}Ca or ^{85}Sr could be simulated on the basis of the 2-compartment model. The validity of the 2-compartment model was analyzed with the aid of an electronic digital computer on the basis of data obtained from previous studies of 4-compartment models. (BBB)

12773 YIELD OF POTASSIUM FROM THE SPLEEN AND KIDNEYS OF IRRADIATED MICE IN THE EARLY POST-RADIATION PERIOD. Burdin, K. S.; Parkhomenko, I. M. Nauchn. Dokl. Vysshei. Shkoly, Biol. Nauki, No. 1, 94-7(1966). (In Russian).

The yield of potassium ions from isolated tissues of animals in the first hours after irradiation was studied as a function of the radiation dose and treatment with certain protective substances (vinyl-pyrrolidone and acryl amide). The authors propose that the increase in yield of K^+ after a massive dose of gamma rays indicates liberation of proteolytic enzymes. Preradiation injection of low molecular substances capable of polymerization results in suppression of K^+ yield. Pyridine suppressed the K^+ yield from the kidneys and spleen of unirradiated animals. Comparison of the effect of aminoethyl isothiuronia, pyridine and the monomers on K^+ yield supports the

idea that in connection with irradiation K^+ yield is associated with destruction of intracellular surfaces of division (lysomers). Monomers capable of inoculation in the lipid fractions sharply reduce the K^+ yield from the cells. (JPRS)

12774 SOME FACTORS INFLUENCING THE DETERMINATION OF PHOSPHATASE ACTIVITY IN NATURE SOILS AND IN SOILS STERILIZED BY IRRADIATION. Ramirez-Martinez, J. R.; McLaren, A. D. (Univ. of California, Berkeley). Enzymologia, 31: 23-38(July 31, 1966).

Samples of fresh, partially dry, and air-dried soil were placed in polyethylene bags and irradiated with an electron beam linear accelerator. Doses of at least 5 Mrad were delivered to each soil packet. Moisture content of the irradiated soil samples was determined immediately after irradiation. Phosphatase activity of soils was examined as a function of pH. Most of the soils tested showed the highest phosphatase activity around neutral pH. The optimum pH for phosphatase activity in both native and sterile irradiated Dublin soil was found to be around neutral pH with either glycerophosphate or β-naphthylphosphate as substrate. This suggests that the optimum pH for phosphatase activity in soils is independent of the substrate used. In an attempt to relate soil phosphatase activity and microbial numbers, no correlation could be found between the seasonal variation in microbial numbers and phosphatase activity. Significant but small seasonal variation of phosphatase activity was observed. Increases in both phosphatase activity and microbial numbers were found following inoculation of sterile, irradiated soil with a trace of native soil. The lower the moisture content of the soil at the time of irradiation, the less was the inactivation of phosphatase activity observed in soil irradiated with an electron beam at a given dose. A possible interpretation of the results is that the phosphatase activity in soils more than reflects the metabolic activities of live microbes and includes a relatively stable, extra-cellular component of enzyme in soil humus. (BBB)

12775 FORMATION OF RIBONUCLEOSIDES FROM BASES BY NUCLEOSIDE PRODUCING MUTANTS OF BACILLUS SUBTILIS. Yamanoi, Akio; Hirose, Yoshiteru (Ajinomoto Co., Inc., Japan). J. Gen. Appl. Microbiol. (Tokyo), 11: 269-72(Sept. 1965).

A report is made on Bacillus subtilis No. 740, inosine producing mutant obtained from Bacillus subtilis No. 20932 by X-ray irradiation. It produced about 20 mM (ca. 5.3 g/liter) inosine de novo in growing culture. Twenty-four hours after 22 mM of hypoxanthine was added the cells had nearly reached the stationary phase and the concentration of inosine was considerably increased with most of the hypoxanthine disappearing; 48 hours after the addition of the base, nearly all the added hypoxanthine had been converted to inosine. The molar ratio of consumed hypoxanthine to inosine formed from hypoxanthine was calculated to be about 1. This "salvage" synthesis of inosine also occurred in non-proliferating washed cell suspensions. Further, this "salvage" synthesis proceeded well in the absence of ammonium ion, while the de novo formation of inosine did not; the omission of phosphate ion remarkably stimulated the latter but little influenced the former. Bacillus subtilis No 167, an orotidine producing mutant, had the highest ability to form orotidine from orotic acid among all other strains tested, and Bacillus subtilis No. 357, an xanthosine producing mutant, formed xanthosine from xanthine. It appears that a base is converted to its riboside by the mutant, which produces de novo riboside of the base more readily. (auth)

12776 THE EFFECT OF RADIATION ON THE FINE STRUCTURE AND ENZYME CONTENT OF THE DOG PANCREAS. II. LONG TERM STUDIES. Wellmann, Klaus F.; Volk, Bruno W.; Lewitan, Alexander (Jewish Chronic Disease Hospital, Brooklyn). Lab. Invest., 15: 1007-23(June 1966).

Effects of a single large dose of x rays (5000 to 9000 R) on the fine structure and function of the exteriorized residual pancreas of 17 partially depancreatized dogs were investigated at intervals from 3 weeks to 1 yr postirradiation. The ultrastructural alterations could be separated into three distinct, but overlapping, stages. The degenerative phase, covering the first few weeks but extending into the second and third postirradiation months, was characterized by focal cytoplasmic degradation, the presence of pleomorphic electron-dense material, alterations of the endoplasmic reticulum and of the mitochondria, and by the reduction in size and number of mature zymogen granules. The recovery phase, beginning during the third week but reaching its peak during the third and fourth postirradiation months, was characterized by the gradual disappearance of cytoplasmic lesions, reorientation of endoplasmic reticulum, and reappearance of morphologically normal zymogen granules. In the third phase, a normalization of the ultrastructural pattern occurred during the sixth to ninth months. Mild inflammatory reactions during the first few weeks and moderate fibrosis later accompanied these alterations. Amylase, leucine aminopeptidase, and lipase activities showed greatly diminished values to the end of the year-long observation period. The endoplasmic reticulum and the Golgi apparatus, involved in protein synthesis and zymogen granule formation, may have been damaged in a way not recognizable by morphologic techniques. Of the same three enzymes measured in the serum, only one, lipase, showed permanently decreased activity from the third month on. The electron microscopic alterations in the pancreatic B cells followed the same pattern as outlined above for the exocrine acinar cells but were much less pronounced, both in severity and in extent. Their function, as measured by weekly blood sugar determinations and monthly glucose tolerance tests, remained unimpaired throughout. The pancreatic A cells displayed only occasional minor structural alterations. (BBB)

12777 INCREASED URINARY EXCRETION OF ^{32}P AFTER A SINGLE INJECTION OF EXTRACT FROM THE POSTERIOR LOBE OF THE HYPOPHYSIS AND AFTER SYNTHETIC LYSINE-VASOPRESSIN IN THE RELATIONSHIP TO THE RADIATION DISEASE. Kolousek, J.; Stojan, B.; Queisnerova, M. (Charles Univ., Prague). Neoplasma, 13: 591-608(1966).

Single injection of an extract, fraction No. 3 from the posterior lobe of hypophysis and synthetic lysine-vasopressin in a dose of 1 I. U. (5×10^{-6} g) and 12 I. U. increase ^{32}P urinary excretion in rats, the maximum being after two hours. Vasopressin affected the water intake and the excretion of urine in rats. An injection of fraction No. 3 of the extract from the posterior lobe of hypophysis and synthetic lysine-vasopressin stimulate ^{32}P urinary excretion in rats after the whole body irradiation by x ray (600 r). The degree of the stimulation depends on the dose of the substances. The increased ^{32}P urinary excretion is evoked by the effect of vasopressin upon the excretory mechanism in kidneys. Adrenals do not influence the phosphodiuretic effect of vasopressin. A single injection of d-aldosterone significantly decreased ^{32}P urinary excretion. Vasopressin is an important factor in the mechanism controlling the metabolism of phosphorus in the body and in the development of radiation disease. Extract from the posterior lobe of the hypophysis was prepared. After the separation with paper electrophoresis and isolation of six fractions were obtained. Fraction No. 3 corresponds to vasopressin. (auth)

12778 LIVING ROOT SYSTEM DISTINGUISHED BY THE USE OF ^{14}C. Ueno, M.; Yoshihara, K.; Okada, T. (National Inst. of Animal Industry, Chiba, Japan). Nature, 213: 530-2(Feb. 4, 1967).

It is stated that there is no adequate method to distinguish a functional from a non-functional or presumably dead root. In the study described $^{14}CO_2$ was applied to the leaves of Italian ryegrass seedlings and the translocation of labeled assimilates to various parts of the root system traced by autoradiography. The radiographs showed that the assimilates were not readily transferred to the dead parts of the root system. The technique may be applicable to growing plants. Some problems associated with the technique are mentioned. It is thought that the technique may provide an approach to understanding the function of roots, particularly in perennial herbs. (auth)

12779 EVIDENCE FOR HETEROGENEOUS TURNOVER OF IODINE IN RAT THYROID GLANDS. Rosenberg, Lawson L.; LaRoche, Gilles; Ehlert, Jacqueline M. (Univ. of California, Berkeley). Endocrinology, 79: 927-34(Nov. 1966).

The question of homogeneous vs. heterogeneous turnover of thyroidal iodine was tested in rats by comparing the fractional rates of loss of ^{127}I and of ^{131}I from thyroid glands labeled, each, with a single injection of the radioisotope and then depleted of iodine by chronic administration of propylthiouracil (PTU). Two experiments were done; in Experiment I rats were injected with ^{131}I 4 hr (Group I) or $3\frac{2}{3}$ days (Group II) before initiation of the PTU regimen, and in Experiment II 4 hr (Group I) or 4 days (Group II) before PTU. Specific activities of thyroidal iodine determined at later times from 1 hr to $4\frac{1}{4}$ days (Experiment I) or from 1 hr to $7\frac{3}{4}$ days (Experiment II) decreased logarithmically with time; in each experiment, the slope of the line for Group I was significantly steeper ($p < .001$) than that for Group II, and the slope of each line was significantly different ($p < .001$) from zero. Thus, iodine (^{131}I) which entered the thyroid during a 4-hr period immediately prior to chronic blockage of hormonogenesis with PTU was lost more quickly than "older" iodine accumulated during the period 4 days prior to PTU, and which was, in turn, lost more quickly than ^{127}I that represented a wide spectrum of ages from very old to very new. The data confirm experimental results of Triantaphyllidis (1, 2) and of Schneider (3) and indicate that thyroidal iodine is turned over in a heterogeneous manner. (auth)

12780 EFFECT OF A MALIGNANT TUMOR ON THYROXINE METABOLISM AND THYROID FUNCTION IN THE RAT. Galton, Valerie Anne; Ingbar, Sidney H. (Dartmouth Medical School,

Hanover, N. H. Boston City Hospital, Harvard Medical School, Boston). Endocrinology, 79: 964-70(Nov. 1966).

The effects of a malignant tumor (Walker 256) on thyroid hormone economy were assessed. PBI in serum was considerably reduced in tumor-bearing animals. Urinary excretion of ^{131}I in tumorous rats isotopically equilibrated with ^{131}I-labeled thyroxine T_4 (5 μg/day) was significantly greater than in corresponding control animals, indicating that the deiodination of T_4 was increased. This increase was associated with a reduction in the concentration of ^{131}I-T_4 in serum; thus, the rate of clearance of T_4 from plasma was greatly increased in the tumorous rats. This increase was due, not only to the enhanced rate of deiodination, but also to an increased rate of clearance by the gastro-intestinal pathway. The increased rate of clearance was apparently not the result of a primary stimulation of intracellular deiodinating mechanisms; no change in the in vitro deiodination of T_4 in tissues of tumorous animals was observed and deiodination by the tumorous tissue itself was minimal. In tumorous animals, increases were noted in the proportion and absolute concentration of free T_4 and in the red blood cell uptake of ^{131}I-T_4 from serum. Studies of the thyroid gland indicated hypofunction; the rate of uptake of iodide by the gland was greatly decreased in the tumorous animals, although glandular iodine content was unchanged. It is concluded that the changes in thyroid hormone economy in tumorous animals are secondary to decreased protein binding of T_4, but it is not known whether this represents a nonspecific response to illness or a specific effect of the tumorous state. (auth)

12781 STUDIES ON NODULAR GOITER WITH RADIOACTIVE PHOSPHORUS (^{32}P). PART II. PHOSPHORUS FRACTION ON NODULAR TISSUE. Yamaguchi, Tomoyasu (Shinshu Univ., Korea). Shinshu Igaku Zasshi, 14: No. 1, 38-50(May 1965). (In Japanese).

The metabolism of phosphorus was investigated of thyroid cancer and simple nodular goiter. The phosphorus content was measured in the tissues of thyroid cancer and simple nodular goiter, and also the ratio of the phosphorus content was calculated as nodule/normal. In thyroid cancer the content and the ratio of phosphorus were more increased in each fraction than in simple nodular goiter. These were more remarkable in the fractions of acid soluble phosphorus, RNA, and DNA. Histologically it was evident that the content and the ratio in these three fractions were most increased in tubular adenoma. The radioactivity of the ^{32}P incorporated into the tissues of nodular goiter and normal thyroid was counted after fractionation of the phosphorus compound. The ratio of nodule/normal of ^{32}P radioactivity in the fractions of acid soluble phosphorus, RNA, and DNA was considerably higher in thyroid cancer than in simple nodular goiter. Of the different types of simple nodular goiter, the ratio of ^{32}P radioactivity of tubular adenoma was most increased in all fractions except phosphoprotein. The ^{32}P specific radioactivity of thyroid cancer was found to be considerably higher in every fraction than that of simple nodular goiter. Histologically the ^{32}P specific radioactivity was highest in tubular and follicular adenomas, especially in the former. It can be summarized that the phosphorus metabolism is more increased in thyroid cancer than in simple nodular goiter. In simple nodular goiter it is more increased in tubular adenoma and follicular adenoma than in other adenomas. (auth)

12782 PRIMARY REACTIONS IN RADIATION BIOLOGY. Minder, Walter. Strahlentherapie, 132: 24-32(Jan. 1967). (In German).

Energy concentrations along electron tracks will cause physicochemical changes in biological material. In a molecular assembly, however, the events produced are very rare and widely spaced depending on the electron energy. An electron excitation or an ionization of a certain molecular unit is the result of ill-known events, which take place in relatively large molecular complexes within a period between 10^{-17} and 10^{-13} sec. The presence and participation of bound water molecules is a basic factor for these reactions which cause the macroscopically manifest changes. (auth)

12783 STUDIES ON RADIOSENSITIVITY OF DNA. II. RADIATION INJURY TO THE DNA MOLECULE IN THE IRRADIATED CELL. Hagen, Ulrich; Keck, Klaus; Zimmermann, Friedrich; Kroeger, Hans (Univ., Freiburg i. B. Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 132: 40-50(Jan. 1967). (In German).

Various methods were employed to investigate DNA preparations isolated from the thymus of irradiated mice or rats as well as from irradiated thymus-tissue and from thymocytes. The molecular weight determined by sedimentation analysis, the melting point and the base composition of the DNA served as criteria for radiation damage. Furthermore, the biological activity of the DNA was examined by their priming ability for enzymatic RNA synthesis. Radiation induced changes could be seen only by sedimentation analysis. Melting point, base composition and biological activity did not show any response to radiation. Immediately after whole body irradiation with doses up to 4000 R no changes were observed in the sedimentation distribution. Samples of DNA, isolated from tissues or cells after irradiation with 100 to 400 kRad however show dose dependent breaks in the nucleotide chain. These breaks were mostly double breaks. When the DNA was isolated a few hours after lethal whole body irradiation degraded DNA molecules were found. These derive from dead cells with a pycnotic nucleus. (auth)

12784 EFFECTS OF STRONTIUM IONS ON HEART MUSCLE. II. INFLUENCE ON EXCITABILITY, CONDUCTION, AND POTASSIUM EFFLUX. Weyne, J. (State Univ., Ghent, Belg.). Arch. Int. Physiol. Biochim., 74: 461-75(1966).

The influence of substitution of extracellular Ca by Sr on excitability and conduction in papillary muscle, isolated heart of rats and frogs, and isolated auricle of cats and rabbits was studied. The K efflux was measured in cat papillary muscles. In isolated hearts of the frog and rat the substitution of Ca by Sr slowed the spontaneous contraction rhythm. Results obtained in rat heart, however, were complicated by the appearance of atrio-ventricular (A-V) dissociation. In the presence of 10% Ca the sinus rhythm was intermediate between the frequencies seen in the Ca and Sr solution; A-V dissociation did not occur and the presence of 10% of Ca even abolished such dissociation caused by Sr medium. The same negative chronotropic effect was observed in the isolated cat atrium. The spontaneous rhythm of atrium was markedly depressed after removal of $^2/_3$ of the Ca and after substitution of Ca by Sr. The rate in a normal solution was dependent on Ca concentration. The lowered frequency of contraction after substitution of Ca by Sr was less dependent on the concentration of Sr. After substitution of Ca by Sr there was a marked decrease of conduction. When a papillary muscle loaded with ^{42}K was transferred to an inactive solution, there was first a rapid loss of ^{42}K, followed by a much slower phase. The first component was due to loss of extracellular ^{42}K, and the second component to the exit of intracellular ^{42}K. In quiet preparations, no influence of Ca privation on the K efflux was seen. When Ca was omitted or substituted by Sr of stimulated preparations, the rate increased. The increase of the efflux of ^{42}K was reversible and normalization occurred after returning to a normal Ca-containing solution. It is concluded that Sr depresses spontaneous frequency, direct excitability, and conduction velocity. Absolute and effective refractory periods were prolonged and the K efflux in stimulated papillary muscles was increased by Sr. (BBB)

12785 EFFECTS OF STRONTIUM IONS ON HEART MUSCLE. I. INFLUENCES OF CONTRACTILITY. Weyne, J. (State Univ., Ghent, Belg.). Arch. Int. Physiol. Biochim., 74: 449-60(1966).

Effect of the substitution of extracellular Ca by Sr on contractility of papillary muscles of the cat and isolated hearts of the rat and frog was studied. Substitution by Sr resulted in a positive inotropic effect on the frog heart and on the papillary muscle of cat heart. Addition of Sr ion to a Ca-free Ringer solution restored contractility of frog heart in the same way as did addition of Ca ion; usually the increase was more marked after the addition of Sr but the speed of restoration of contraction was faster with Ca ion. In the isolated rat heart electrically driven at a frequency just higher than the intrinsic contraction rate (120/min), the amplitude of the contractions decreased after substitution of Ca by Sr and the most pronounced effect of the Sr ion was a marked increase in tone. In spontaneously beating frog and rat hearts the same effects on contractility were observed as in the electrically stimulated preparations. In both isolated frog heart and papillary muscle of the cat there was a marked prolongation of the contraction in Sr-containing solution. This was especially true at low frequencies. From the changes observed in the duration of the contraction phenomena, in the rate of tension development, and in the force-velocity relation in papillary muscle, this positive inotropic effect is attributed to a prolongation of the active state which offsets a decreased degree of activation. In Sr-containing medium the interaction of frequency with contractility persists but the tension developed at infraoptimal frequencies is higher and the optimal frequency is lower than in a normal medium. (BBB)

12786 IS THE DEFECTIVE REACTION TO PHYTOHEMAGGLUTININ SHOWN BY THE LYMPHOCYTES FROM LYMPHOCYTIC LEUKEMIA DEPENDENT ON THEIR INNATE STRUCTURE OR ON PLASMATIC CHARACTERISTICS? Astaldi, G.; Costa, G.; Airo, R.; Duate, N. (Ospedale Civile, Tortona, Italy). Acta Med. Scand., 179: Suppl. 445, 319-25(1966).

The addition of plasma from chronic lymphocytic leukemia (CLL) to phytohemagglutinin (PHA)-containing culture medium in which lymphocytes from healthy persons were cultured inhibited the development of these cells. On the other hand, the serum from the

same CLL patients had no inhibiting effect on normal lymphocytes in the PHA-culture medium system. The CLL plasma was no longer inhibitory when kept at 56°C for 30 min or at 4°C for 2 weeks, or after x irradiation in vitro with 500-R doses. Moreover, irradiation of the spleen of CLL patients enables the lymphocytes from these patients to develop blast forms after PHA stimulation in a percentage as high as that obtained in culture of lymphocytes from healthy persons. It was also observed that the plasma of these irradiated patients loses its capacity of inhibiting the PHA responsiveness of lymphocytes from healthy persons. Peripheral blood lymphocytes from CLL patients, washed 1 to 4 times and then cultured in a medium containing plasma from healthy persons, did not change their usual hyporesponsiveness to PHA stimulation in tissue culture. (BBB)

12787 INHIBITION OF STROMAL ENZYMES BY X-RADIATION. Myers, D. K.; Church, M. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nature, 213: 636-7(Feb. 11, 1967).

High doses of x radiation appear to alter the function of the erythrocyte membrane without producing much change in the internal metabolism of cells. In order to determine the membrane changes more precisely a study was made of the effects of x rays on various enzymes in isolated stroma. Marked differences in the radiosensitivity of these enzymes were observed. Acid phosphatase was the most radiosensitive of the enzymes studied, and measurable inhibition was observed at doses as low as 4 Krads. Qualitatively similar results were observed with nucleoside phosphorylase and acetylcholinesterase. The inhibition of enzymes by X-irradiation has been attributed to oxidation of sulfhydryl groups, but present results make it appear unlikely that the effect can be attributed primarily to oxidative reactions. It was found that the effects of x rays on stromal enzymes could be partly reproduced by reducing agents, and the data suggest that part of the radiation effect may be caused by reduction of $-S-S$ bridges, with subsequent disruption of protein structure. (UK)

12788 HIGHLY RADIOACTIVE FALLOUT PARTICLES INGESTED BY MICE. Yoshida, Sachiko; Oki, Iwashiro; Tchoe, Yuong-tchel (Osaka Public Health Inst.). J. Radiat. Res. (Jap.), 7: 112-13(June 1966).

Spherical particles of high radioactivity were collected after the Chinese nuclear explosion of May 9, 1966. These were fed to mice and after 20 hours the particles were excreted in the feces. The radioactive recovery was almost 100%. Radioactivity was not detected in the urine. (H.L.W.)

12789 THE USE OF AN ELECTRON-DENSE MARKER IN THE STUDY OF PINOCYTOSIS IN MAMMALIAN CELLS GROWN IN TISSUE CULTURE. Holmes, I. H.; Watson, D. H. (Glasgow Univ.). J. Roy. Microscop. Soc., 82: 273-7(Mar. 1964).

Thorotrast uptake by cells in vitro was studied. BHK-21 (hamster kidney) cells in tissue culture were exposed to growth medium containing colloidal thorium dioxide. Electron microscopy of thin sections of these cells showed Thorotrast to be present in the pinocytotic vesicles. The fate of these marked vesicles was followed by electron microscopy of thin sections of cells incubated in growth medium without Thorotrast for varying periods after exposure to Thorotrast. The vesicles in these cells were often smaller and occasionally fused together. Only rarely was breakdown of the vesicles detected by release of Thorotrast into the cytoplasm. The less efficient adsorption of Thorotrast by BHK-21 cells seen here as compared with Amoeba is probably due to the absence of the surface filamentiferous zone. The features of contraction of the vesicles, enhanced density of the background matrix of smaller vesicles, and the vesicle fusion are consistent with previous observations. The mechanism whereby the contents of the vesicle are released into the cell is uncertain. The rare instances in which release into the cytoplasm from disrupted vesicles was seen do not indicate that this is a general mechanism for release of metabolites into the cell. The observed linkage of Thorotrast-marked vesicles with concentric membrane structures might then be of significance in considering the fate of pinocytotic vesicles and the relation between the cell (surface) membrane and those found within the cell. (BBB)

12790 STRUCTURAL MODIFICATIONS OF DNA: CROSS-LINKING, CIRCULATION, AND SINGLE-STRAND INTERRUPTIONS. Szybalski, Waclaw (Univ. of Wisconsin, Madison). Abhandl. Deut. Akad. Wiss. Berlin, Kl. Med., No. 4, 1-19(1964).

Modifications of the secondary structure of double-stranded DNA, as occurring in nature or provoked by exposure of the cells to various lethal agents, including ionizing radiations are reviewed. Structural features of DNA and pre-existing single-strand breaks are discussed in relation to their possible biological significance, including the control of DNA synthesis, the mechanism of genetic recombination, and lethal or mutagenic effects. (BBB)

12791 EFFECT OF X IRRADIATION ON THE CELLULAR SULFHYDRYL CONTENT. Revesz, L.; Modig, H. (Karolinska Institutet, Stockholm). Ann. Med. Exp. Biol. Fenn. (Helsinki), 44: 333-7(1966).

Nonprotein-bound sulfhydryl (NP-SH), nonprotein-bound disulfide (NP-SS), and protein-bound sulfhydryl (P-SH) levels in Ehrlich ascites tumor cells were determined after treatment in vitro, either in the presence of oxygen or in oxygen-free argon, with x-ray doses varying between 1000 and 4000 R. With increasing doses, a gradual decrease in the cellular content of NP-SH and P-SH was found. Compared to the effect of anoxic irradiation, treatment in oxygen was about 3 times more effective in decreasing the NP-SH, and about 1.5 times more effective in decreasing the P-SH level. The NP-SS level increased with increasing x-ray doses. After treatment under anoxic conditions, the increase in the amount of NP-SS corresponded closely to the decrease in the NP-SH amount. In the presence of oxygen, NP-SS was formed in amounts in excess of the NP-SH decrease. Physiologically occurring mixed disulfides between glutathione and P-SH, demonstrated in previous experiments, were considered as the source of the excess NP-SS and to explain the difference in the oxygen enhancement in decreasing NP-SH and P-SH levels. (BBB)

12792 RADIOBIOLOGICAL EFFECTS OF TRACERS USED IN PLANT PHYSIOLOGY. Dejaegere, R. (Univ. Libre, Brussels). Ann. Gembloux, 70: 12-20(First Quarter 1964). (In French).

The use of radioactive tracers in biological experiments is based on the premise that the tracer does not influence normal processes in the cell. Evidence is presented that this condition is not always realized, and that in some instances radiation from the radioactive tracer affects cellular metabolism. For example, addition of ^{32}P to germinating pea seeds increases the weight of aerial parts and the number of roots up to a concentration of 10^{-2} mCi/l, while decreasing the weight of above-ground parts at 10^{-1} mCi/l. Radium (10^{-10} g/kg) and uranium (10^{-4} g/kg) in the soil increase the yield of tobacco (35 and 15%, respectively). Numerous other experiments are cited to show that ^{32}P stimulates plant growth when added at optimal concentrations, then inhibits it at higher concentrations. A parallel effect was seen with ^{35}S. When ^{32}P was added at a level of 0.5 to 1.2 mCi/pot, it increased various growth parameters of cotton plants; for example, an 11% increase in hypocotyl length and 10% increase in weight of aerial parts. Possible mechanisms whereby the stimulating effect may occur, including effects on the auxin system, are discussed. It is concluded that the biological effects of radioelements used as tracers are not always negligible and that it is not always possible to predict whether their effect will be stimulatory or inhibitory. (BBB)

12793 EFFECTS OF IRRADIATION ON CANCER TOXIN IN TUMOR-BEARING HOSTS. Suga, Shoji (Nagoya Univ., Japan). Nagoya J. Med. Sci., 28: 142-61(Mar. 1966).

To study the effects of ionizing radiation on the cancer toxin, toxohormone, in tumor-bearing hosts, crude toxohormone fractions were prepared from preoperatively ^{60}Co γ-irradiated human gastric cancer. It was shown that irradiation reduced the liver catalase-depressing action of the crude toxohormone fractions, but the yield of the fractions was less affected. Amberlite XE-64 column chromatography of the fractions revealed a decrease in the amount of the TH 2 fraction, which possessed the most potent catalase-depressing action. Histological findings in the ^{60}Co γ-irradiated cancer included focal necrosis and/or fibrosis of the tissue and degenerative changes of cancer cells, which varied in severity. Irradiation effects on cancer toxin were then investigated in connection with the tumor growth, using mice bearing a diploid Ehrlich ascites tumor. In tumor-bearing mice, a decrease in liver catalase activity was observed 10 hr after irradiation with 200 or 500 R of x rays. The decrease was attributed to increased release of the cancer toxin from the irradiated tumor cells. After 500 R, the arrest of cell division occurred, whereas the average cell volume continued to increase. On the other hand, liver catalase activity increased 48 hr after irradiation. This later increase in liver catalase activity was also observed frequently after exposure to 200 R. Such an irradiation effect was, however, diminished by the concomitant administration of a radioprotective agent, cysteine. No influence of cysteine was observed on the early decrease in liver catalase activity. The later increase in liver catalase activity was interpreted as the result of a lowered amount of the cancer toxin after irradiation because of decreased synthesis de novo of the toxin. Radiosensitive enzymes may control the synthesis of the cancer toxin by the tumor cells. (BBB)

12794 EFFECT OF ^{32}P DECAY UPON DNA SYNTHESIS BY A RADIATION-SENSITIVE STRAIN OF ESCHERICHIA COLI. Cairns, John; Davern, Cedric I. (Cold Spring Harbor Lab., N. Y.). J. Mol. Biol., 17: 418-27(June 1966).

The DNA molecule that comprises the chromosome of Escherichia coli is duplicated at a fork which traverses the entire length of the molecule. The 3 ends of the Y-shaped molecule are, however, attached to some structure which survives lysis of the cell.

It is postulated that this structure must contain at least one swivel in order to permit the continual rotation that presumably accompanies the progressive separation of the two parental polynucleotide chains during DNA duplication. The experiments reported were done to test this hypothesis about the mechanism of DNA replication in vivo. Although the most conspicuous prediction of this hypothesis was fulfilled, the results were not decisive. It was shown that a certain minor class of ^{32}P-decays anywhere in the DNA of a ^{32}P-sensitive bacterium can stop DNA synthesis without detectable delay, but there was no evidence, direct or indirect, that this class of lesion represents two-strand breaks as demanded by the hypothesis. Even if it is assumed that the critical lesions in the ^{32}P-sensitive strain of E. coli are two-strand breaks (which are repaired or somehow circumvented by a strain that is not ^{32}P sensitive), there is still no evidence that DNA replication stops because the replicating fork is no longer subject to torque. It can be imagined that a break anywhere in the chromosome leads to some change of state of the chromosome which either directly prohibits replication or leads, as part of the general breakdown that ensues, to a break immediately ahead of the replicating form and therefore, indirectly, to the cessation of replication. The distinction between these and other possibilities demands other kinds of experiment. (BBB)

12795 HIGH-YIELD LABELLING OF ALBUMIN WITH ^{131}I BY MEANS OF CHLORAMINE-T. Entzian, W.; Dohr, H. (Univ., Bonn). Atompraxis, 12: 516-18(Oct. 1966). (In German).

The article describes a simplified modification of the method given by Greenwood, Hunter, and Glove for tagging albumin with radioiodine; it uses only chloramine-T. With a molar composition of albumin, carrier-free ^{131}I, and chloramine-T in a ratio $1:2.2\times10^{-4}:5-16$, a practically complete depositing of the iodine on the protein can be obtained. No alteration in the albumin has been observed in regard to its electrophoretic or immunological behavior, or in determinations of biological half-life in animal experiments. (auth)

12796 THE EFFECT OF BURN CONVALESCENT SERUM ON THE DURATION OF ERYTHROCYTE-^{51}Cr HALF-LIFE IN DOGS WITH THERMIC BURNS. Pozdnyakova, Z. G. Patol. Fiziol. Eksp. Terap., 10: No. 5, 48-50(Sept.-Oct. 1966). (In Russian).

In experiments on 25 dogs a study was made of the change in the period of half-life of erythrocyte-^{51}Cr under the effect of immunotherapy in thermic burn (15–20% of body surface). The labeled erythrocytes of experimental animals, obtained before the burns were administered 48 hours after the burn. Treatment with normal serum and with the serum of burn convalescents was started 4 hours and continued for 5 days after the trauma. The first 24 hours after the administration normal serum therapy proved to reduce somewhat the accidental destruction of labeled erythrocytes (25%) in comparison with untreated control dogs (32%), whereas the half-life period remained unchanged (12 days). Under the effect of treatment of burned dogs with convalescent serum accidental destruction within the first 24 hours after the administration constituted but 15% of labeled erythrocytes, whereas the half-life period was prolonged to 18 days. (auth)

12797 RECONSTRUCTION IN VIVO OF IRRADIATED ESCHERICHIA COLI DEOXYRIBONUCLEIC ACID; THE REJOINING OF BROKEN PIECES. McGrath, R. A.; Williams, R. W. (Oak Ridge National Lab., Tenn.). Nature, 212: 534-5(Oct. 29, 1966). (ORNL-P-1594).

Pieces of single stranded DNA approximately one sixth of the strand length believed to exist in E. coli were obtained. Breaks induced by x rays in DNA molecules were observed and changes in the number of breaks with time after irradiation were followed. The increase in sedimentation rate following irradiation indicated a repair process that rejoins broken pieces of DNA with bonds stable in alkali. The increasing molecular weight during incubation after irradiation represents an enzyme repair process that joins together most of the broken pieces of DNA. (H.L.W.)

12798 BIOLOGICAL CONCENTRATIONS OF ^{137}Cs AND ^{90}Sr IN ARCTIC FOOD CHAINS. Witkamp, Martin. Nucl. Safety, 8: 58-62(Fall 1966).

Efficient foliar sorption of fallout minerals and their transfer without much dissipation along the arctic food chain from lichen via caribou and reindeer to human inhabitants of inland communities lead to body burdens of ^{137}Cs and presumably of ^{90}Sr that are several times higher than those of the rest of the world population. Reasons for these higher than average body burdens are not high fallout levels but rather the unique ecological conditions of the closed and marginal economies of vegetation, fauna, and man in the arctic environment. (auth)

12799 MAXIMUM CONCENTRATION FACTORS OF ^{90}Sr FOR BROWN ALGAE. Kulebakina, L. G. (Inst. of Biology of South Seas, Academy of Sciences, Ukrainian SSR). Dopov. Akad. Nauk Ukr. RSR. No. 10, 1318-20(1966). (In Ukrainian).

The maximum concentration factor of ^{90}Sr for Cystoseira barbata was determined. It is equal to 55. The values of the concentration factors of ^{90}Sr in this species possibly do not depend on the season. (auth)

12800 AUTORADIOGRAPHY OF ^{32}P IN MAIZE ROOTS. Crossett, Robert N. (Univ. of East Anglia, Norwich, England). Nature, 213: 312-13(Jan. 21, 1967).

Autoradiography of frozen tissue sections was used to locate ^{32}P in transverse sections of maize roots. The variation in optical density over the autoradiograph was measured using a microdensitometer, which was adjusted to continuously measure the optical density of a square. Qualitative results showed that: ^{32}P is more concentrated in the vessel elements than in the surrounding phloem and parenchyma; a concentration gradient of ^{32}P extends across the root cortex toward the endodermis with a point of inflexion appearing midway between the epidermis and endodermis; an accumulation of ^{32}P corresponding to the surface of the root, bacteria on that surface, or the epidermal cells is evident. Detection of the concentration gradient and the inflexion point illustrated the greater sensitivity of microdensitometry as compared to visual analysis of preparations or photographs. (H.G.D.)

12801 EFFECT OF IONS ON ANGIOTENSIN INTERACTION WITH SMOOTH MUSCLE. Khairallah, P. A.; Vadaparampil, G. J.; Page, I. H. (Cleveland Clinic Foundation). Arch. Int. Pharmacodyn., 158: 155-64(Nov. 1965).

The effects of variation in the ionic concentration of Sr, Mg, Ca, Na, and K ions on the in vitro action of acetyl choline, angiotensin, and bradykinin in smooth muscle of guineapig ilea and diethylstilbesterol-treated rat uteri were determined. Results showed that Ca^{++}, at a concentration of 0.9 meq/l inhibited the response of uterine muscle to angiotensin; Sr^{++}, at a concentration of 2.7 meq/l, increased response to 95% of control values; Ca^{++}, at a concentration of 0.7 meq/l, and Sr^{++}, at a concentration of 2.9 meq/l, produced responses of ~70% of control values; and Sr^{++}, at a concentration of 3.6 meq/l (total replacement of Ca^{++} with Sr^{++}), inhibited response. It was found that uterine muscle was still active when 80% of Ca^{++} present was replaced by Sr^{++}; that replacement of 85% of Ca^{++} present with Sr^{++} (0.5 meq/l Ca^{++} and 3.1 meq/l Sr^{++}) completely inhibited response to angiotensin. Results also showed that Na^+, at a concentration of ½ that present in physiological saline solution (PSS), abolished the response of smooth muscle from the ileum to angiotensin; that Na^+, at a concentration of $\frac{1}{10}$ that present in PSS, abolished the response of uterine muscle to angiotensin; and that Na^+, at the same concentration, abolished response in both uterine and ileum muscle to acetyl choline and bradykinin. It was also found that Mg^{++}, at a concentration of two times that present in PSS, inhibited response to acetyl choline, angiotensin, and bradykinin; that Mg^{++}, at a concentration of ¼ that present in PSS, elicited a potentiation of response to all three compounds. It was learned that this potentiation was abolished when the Ca^{++} concentration was decreased to ¼ that present in PSS and that completely depolarized uterine smooth muscle, obtained by replacing all the Na^+ in PSS with K^+, continued to respond to acetyl choline, angiotensin, and bradykinin. (B.H.S.)

12802 EXCRETION AND BIOSYNTHESIS OF PSEUDOURIDINE AND THYMIDINE BY IRRADIATION. Kosenko, A. S.; Fedorov, N. A. Radiobiologiya, 6: 682-6(1966). (In Russian).

The fraction of newly synthesized pseudouridine after irradiation remains within the normal limits. The excess of the excreted pseudouridine originates principally because of the decomposition of the previously synthesized soluble RNA. The excretion of thymidine appears in the first 24 hours after irradiation and is absent in healthy animals. The determined fraction of excreted thymidine appears newly synthesized. Within 24 hours after whole-body x radiation at doses of 600 R the quantity of cytoplasmic RNA in the liver and the incorporation of ^{14}C-orotic acid in uridylic and cytidylic nucleotides were increased. (tr-auth)

Ecology

Refer also to abstracts 12769, 12798, and 12883.

12803 (PG-Report-752) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. V. RADIOACTIVITY IN THE FAUNA. Perkins, E. J.; Williams, B. R. H.; Gorman, J. (United Kingdom Atomic Energy Authority, Annon (Scotland). Production Group). 1966. 22p. Dep. BIS $0.70, HMSO 3s. 6d.

The specific activity of the nuclides ^{40}K, ^{90}Sr, and ^{106}Ru in cer-

tain of the fauna of the Solway Firth has been examined. It has been shown that at higher tropic levels the specific activity of ^{106}Ru decreases, while the reverse is true for ^{90}Sr. The uptake of ^{90}Sr by the flounder was thought to be related to food intake and it was shown that a peak in the specific activity occurred when the fish were in peak condition. (auth)

12804 NOTES ON BIRD NESTS FOUND IN A DESERT SHRUB COMMUNITY FOLLOWING NUCLEAR DETONATIONS. Rickard, W. H. (Battelle Memorial Inst., Richland, Wash.). Condor, 63: 265-6(May-June 1961).

The occurrences of bird nests at the Nevada Test Site was analyzed in relation to the gross influences of nuclear detonation (air bursts), which occurred prior to September 2, 1957, upon the vegetation of a desert shrub community. The results of field observations of nests of various bird species are reported in a table. The nest found nearest the detonation point was that of a Horned Lark (Eremophila alpestris). This nest was about 0.2 mi from ground zero and was discovered in April, 1960. The destruction of shrubby vegetation appeared to modify the community in favor of Horned Larks. At all seasons populations of Horned Larks were greater in the disturbed area than in the adjacent shrub-dominated vegetation. (TSS)

12805 ENVIRONMENTAL CONTAMINATION WITH RADIORUTHENIUM 1961–1965. Iwashima, Kiyoshi; Yamagata, Noboru (Inst. of Public Health, Tokyo). J. Radiat. Res. (Jap.), 7: 91-111(June 1966).

The results of measurements of medium-lived ^{103}Ru and ^{106}Ru in air-borne particles, fall-out, surface soil, river water, seawater, foodstuffs, complete diet and human muscle and lungs during 1961–1965 are summarized. The main passage route of ^{103}Ru was found through the fresh leafy vegetables, while ^{106}Ru was supplied by different routes, i.e., 77% by plant materials raised on land, 6% by foodstuffs of animal origin and the remainder by seaweed; the concentration was the highest in the last item. Estimation of lung and body burdens was performed on the basis of observed data for inhalation and ingestion and compared with the result of measurements on human materials obtained from cadavers. The mobility of fall-out ruthenium in the sequence between precipitation and run-off from rivers seemed a little larger than strontium and much larger than cesium, reaching 14% of fresh fall-out to be delivered to the sea. The average concentration factor from seawater to sea food as a whole was found to be 70 or equivalent daily intake of sea-water to be 7 kg. On this basis, the maximum permissible concentration of ^{106}Ru in sea-water was suggested as 3×10^{-6} μCi/ml. (auth)

12806 RADIOACTIVITY OF AQUATIC ORGANISMS. PART I. STUDIES OF TOTAL BETA-ACTIVITY. Kang, Man Sik; Chung, Hack Pil. Kisul Yon Guso Pogo, 4: 54-6(1965). (In Korean).

Beta-radioactivity in the total body and in different organs of aquatic organisms were studied. Beta-activity in total body was found to decrease with the order of seaweeds, molluscs, shellfish, fish, and crustaceans. Radioactivity measured in the latter half of the year decreased compared with that of the first half of the year. Highest radioactive contamination was found in flesh, liver, and intestine and least in bone. (auth)

Genetics and Cytogenetics

Refer also to abstracts 12954, 12955, 12967, and 13067.

12807 (NYO–2577-8) DOSIMETRIC MEASUREMENTS IN BRAZILIAN REGIONS OF HIGH NATURAL RADIOACTIVITY LEADING TO CYTOGENETIC STUDIES. Cullen, Thomas L. (Pontificia Universidade Catolica do Rio de Janeiro (Brazil). Instituto de Fisica). [1966]. Contract AT(30-1)-2577. 17p. (CONF-660920-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

Dosimetric measurements made in Guarapari, Brazil, a city built on monazite sands, are reported. Lithium fluoride dosimeters were used to reconstruct the lifetime dose of selected individuals representing various sections of the city, all age brackets, and both sexes. The average dose-rate for the 317 people measured was 636 mR/yr. Population movement on a daily basis within the city tended to equalize the dose. Attempts to measure internal contamination were inconclusive. However, it is believed that intimate contact with contaminated surfaces and dust in the air is the source of body burdens that may have cytological significance. (H.G.D.)

12808 (RISO–117) RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN CELLS. Visfeldt, Jakob (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1966. 187p. Dep. mn.

Thesis.

Four experimental series, the primary object of which was to determine the relationship between chromosome aberrations and radiation dose on the basis of in vivo experiments, are presented. One series deals with studies of chromosome aberrations in long-term cultures from irradiated human skin. Clone formations originating from cells with definite structural chromosome aberrations were observed. All cells capable of reproduction contained balanced karyotypes. Based on studies of chromosome aberrations in short-term cultures of peripheral blood from radiation-treated patients it was shown that all cells with unstable aberrations were seen in the first mitosis after the irradiation, even several years after the treatment. Finally studies of chromosome aberrations after in vitro irradiation were carried out on leucocyte cultures from human peripheral blood. The dose-effect relationship was established and a comparison was carried out with the results from the in vivo experiments. The possible use of chromosome analyses of human leucocytes in biological dosimetry is discussed. (auth)

12809 (UCRL-16898, pp 11-13) SIGNIFICANT DIFFERENCE IN MAMMALIAN-CELL POLYPLOIDY INDUCTION BETWEEN PLATEAU AND "STAR" REGIONS OF A NEGATIVE PION BEAM. Loughman, William D.; Winchell, H. Saul; Raju, Mudundi R.; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

A preliminary report showed that plateau and star (or peak) regions of negative pion beams differ in their capacity to induce polyploidy and other effects on mammalian cells in vivo. Results are reported from further work in which a statistically significant difference between the effects of the two beam regions was demonstrated. Mice with the A-2 lymphoma as an ascites tumor were irradiated in a negative pion beam from the 184-inch cyclotron. Mice in the plateau portion of the beam (about 60% pions) received an average dose of about 230 rads. Mice in the peak region of the beam (30 to 40% pions) received about 350 rads. On the third and fourth days following irradiation, ascites cells were removed from the mice and prepared for chromosome examination, and 4,000 metaphase cells from each mouse were scored as essentially diploid or as polyploid. In each case the incidence of polyploidy among irradiated cells was increased over control values. Significantly higher values were seen in cells irradiated in the beam's peak region than in cells irradiated in the plateau region. (C.H.)

12810 (UCRL–16898, pp 72-81) STUDIES ON DEFICIENT MAMMALIAN CELLS ISOLATED FROM X-IRRADIATION CULTURES. Todd, Paul W. (California Univ., Berkeley. Lawrence Radiation Lab.).

Colonies of deficient cells appear in x-irradiated cultures of human as well as hamster cells. High-LET radiation was more effective than x radiation in the production of deficient cells, by the criterion of small-colony development. Deficient cells were respiratory deficient only to the extent that they consumed less oxygen than normal cells. Hamster cells did not express their inherited deficiencies visibly in their karyotypes. This does not conclude, however, that heritable chromosome abberations cannot result in cellular deficiencies of the type described. (C.H.)

12811 STUDIES ON THE MUTATION OF FOREST TREES. I. ^{14}C FIXATION IN RADIATION INDUCED BUD SPORTS OF CRYPTOMERIA JAPONICA D. DON AND CHAMAECYPARIS OBTUSA ENDL. UNDER CUT-BRANCH CONDITION. Oba, Kihachiro (Inst. of Radiation Breeding, Omiya, Japan); Anma, Yoshiteru. Nippon Ringaku Kaishi, 48: 153-7(Apr. 1966). (In Japanese).

Total fixation and distribution of carbon-14 in various organic fractions in leaves of radiation-induced bud sports of Cryptomeria japonica D. Don, Kuma-Sugi, and Chamaecyparis obtusa Endl. were studied after they had undergone photosynthesis in the air containing labelled carbon dioxide under cut-branch condition, and the following results were obtained: 1) A short-needle bud sport of Kuma-Sugi fixed about 80% of carbon-14 in comparison with that of its control, and showed almost normal distribution of the carbon-14 in all organic fractions except organic acids and amino acids. 2) A chlorophyll deficient creamy-white bud sport of Kuma-Sugi fixed about 18% of carbon-14 in comparison with that of its control, and the carbon-14 was heavily accumulated in sugar. The accumulation was less in other organic fractions except in starch. 3) A light-green bud sport of Chamaecyparis obtusa fixed only 1.5% of carbon-14 in comparison with that of its control, while the carbon-14 was heavily accumulated in organic acids, amino acids and starch ranging 10-20 times than those of the control. The accumulation was less in proteins, polysaccharides and cellulose. (auth)

12812 GENETIC VARIABILITY IN OATS FOLLOWING HYBRIDIZATION AND IRRADIATION. Krull, Charles F.; Frey, Kenneth J. (Iowa State Univ., Ames). Crop. Sci., 1: 141-6(1961).

This study evaluates the amount and direction of radio induced

variability in quantitative characters, and compares the relative efficiency of irradiation and hybridization in hexaploid oats, Avena sativa. The effects of an acute dose of thermal neutron irradiation on the genetic variability of 3 quantitatively inherited characters, heading date, height, and 100-seed weights, in pure line and hybrid populations of oats were evaluated. Plants from irradiated lots of 1000 seeds of both Clintland and Beedee and 2000 F_2 seeds of Clintland X Beedee and nonirradiated lots of 200 Clintland, 200 Beedee, and 2000 F_2 seeds were grown to maturity in the greenhouse in order to minimize the natural crossing that occurs in irradiated field populations. A variance analysis of the data was made. Both the results from the selection experiment and the heritability percentages indicated that the variability created by radiation was equally as heritable as that due to hybridization. (BBB)

12813 LACK OF EXPRESSION OF PARENTAL ISOANTIGEN(S) IN F_1 HYBRID MICE. Cudkowicz, G.; Stimpfling, J. H. (Oak Ridge National Lab., Tenn.). Bibl. Haematol., 23: Pt. 1, 144-8(1965).

F_1 hybrid and parental strain mice of both sexes were exposed to 700 R of 300-kv whole-body doses of x-rays at the age of 12-15 weeks. A few hours later they were injected with 10^6 nucleated femoral marrow cells harvested from donors of the same sex. Growth of the transplanted marrow cells was estimated 5 days later by the incorporation of radioactive 5-iodo-2'-deoxyuridine-^{131}I into newly synthesized splenic DNA. Results showed that marrow cells of parental donors failed to grow when transplanted into irradiated F_1 hybrid recipients if the donors were H-2^b homozygotes and if the recipients were H-2^b heterozygotes. This failure of growth could not be correlated with any other known allele at the H-1, H-2, H-3, or H-4 loci, or with any other aspect of the donor's genetic background. Similarly, ($C_3H \times C_{57}BL)F_1$ hybrids that had been made unresponsive toward $C_{57}BL$ marrow grafts by pre-exposure to $C_{57}BL$ tissue isoantigens were unresponsive, i.e., nonresistant, toward marrow grafts of other H-2^b/H-2^b donors. The findings support the interpretation that genetic interaction involving a subunit of H-2 (associated with the D region) results in lack of expression in F_1 heterozygotes of isoantigen(s) of the H-2^b phenotype, affecting the survival of homozygous parental marrow grafts. (TCO)

12814 EFFECT OF MASS SELECTION AND THERMAL NEUTRON IRRADIATION ON GENETIC VARIANCES IN A VARIETY OF CORN (ZEA MAYS L.). Lonnquist, J. H.; Cota A., O.; Gardner, C. O. (Univ. of Nebraska, Lincoln). Crop Sci., 6: 330-2(July–Aug. 1966). (COO-1512-1).

Estimates were made of genetic variation and the changes that have resulted in the selected populations relative to a corn variety after 6 generations of selection. The 3 populations used included the base population, Hays Golden, an adapted variety maintained without selection; Hays Golden after 6 generations of mass selection, referred to as the H. G. C-6 population; and Hays Golden after 6 generations of mass selection but with the seed irradiated with thermal neutrons in generation 0 and again in generation 2, referred to as the H. G. I-6 population. Improvement in productivity realized from 6 generations of individual selection as measured by differences in the 3 populations studied was 12.7% for the H. G. C-6 and 10.9% for the H. G. I-6 populations relative to the original Hays Golden variety. The two selected populations, H. G. C-6 and H. G. I-6, did not differ significantly in yield but both were significantly higher yielding than the original population. The range in yields of the full-sib families in each population was 0.44 to 0.79 lb/plant for Hays Golden, 0.49 to 0.88 for H. G. C-6, and 0.59 to 0.92 for H. G. I-6. Selection resulted in substantial improvement in productivity with no apparent decline in additive genetic variance as measured in these experiments. A substantially greater amount of additive genetic variance for yield was present in the H. G. I-6 population, a reflection of the irradiation treatments applied. Continued progress in increasing productivity through mass selection appears possible in both populations but especially so in the H. G. I-6 population. (BBB)

12815 MUTATION STUDIES IN ANNUAL CHRYSANTHEMUM. I. RADIATION-INDUCED VARIATION IN FLOWER FORM. Jain, H. K.; Bose, A. K.; Sathpathy, D.; Sur, S. C. (Indian Agricultural Research Inst., New Delhi). Indian J. Genet. Plant Breeding, 21: 68-74(Mar. 1961).

Chrysanthemum carinatum seeds were treated with 15,000 R doses of x rays and 535 X_1 plants were grown in the field. The viability of seeds following irradiation was not drastically affected; 53.5% compared with 64.5% of the controls showed germination. The X_1 plants were as vigorous as the controls although their height was reduced, giving them a bushy appearance. A more characteristic radiation effect was observed in the lack of uniform chlorophyll distribution in the leaves of 5% of the plants. Radiation-induced phenotypic variations included several changes in flower form. Evidence, based on observations on X_4 plants, is presented that shows that the induced changes in flower shape are genetically determined. A recombinant form combining a tubular shape of the petals with the double condition was obtained which appears more attractive than either the control or the induced mutant types. The results suggest that radioinduced variations in annual chrysanthemum offer considerable scope for selecting new varieties. The evolutionary processes responsible for the occurrence of spontaneous and radioinduced variations in annual and perennial species of chysanthemum are discussed, and a mechanism responsible for the greater flexibility characterizing the perennials is proposed. (BBB)

12816 PRODUCTION OF ECONOMICALLY VALUABLE BUD VARIANTS IN ROSES BY TREATMENT WITH X RAYS. Streitberg, Hanna (Institut fuer Obstbau und Zierpflanzenbau, Deutsche Akademie der Landwirtschaftswissenschaften, Dresden). Z. Pflanzenzuecht., 55: 165-82(Apr. 1966). (In German).

Mutants were sought in 2651 buds of 42 different rose varieties which were irradiated with 200-kv x rays at a dose rate of 150 R/min. The doses used were 500, 1500, 2450, 3990, 6000, 8000, and 15,000 R. Bud mortality showed a linear relation to the x-ray dose. The varieties differed in their sensitivity to irradiation. With increasing x-ray dose the mutation rate rose. The individual varieties developed markedly different numbers of bud variants. A total of 14.9% of bud mutations was produced. Of these, 5.8% showed different variations, the remaining 9.1% representing repetitions. Some variations occurred in the vegetative organs but most were variations in flower color and shape. The rose varieties could be separated into 3 groups on the basis of radiosensitivity. Group A showing 50% bud lethality at 1500 to 6000 R, Group B 1000 to 3000 R, and Group C 500 to 1000 R. Of the total number of useful mutants 12.5% were obtained with the 500-R dose, 35% with 1500 R, 25% with 2450 R, 17.5% with 3990 R, 5% with 6000 R, and 5% with 8000 R. (BBB)

12817 CREATION OF BUD VARIANTS IN AZALEAS BY TREATMENT WITH X RAYS. Streitberg, Hanna (Institut fuer Obstbau und Zierpflanzenbau, Dresden-Pillnitz, Ger.). Z. Pflanzenzuecht., 56: 70-87(1966). (In German).

Attempts were made to increase the mutation rate in 49 varieties of azalea plants by x irradiation at doses of 500 to 14,500 R. Selection and further multiplication of bud variants, of practical value for horticulture, were also attempted. A total of 5131 azalea scions and 1898 rooted cuttings was irradiated. The 49 varieties reacted differently to x rays. The results also were influenced by different times of irradiation, additional filtration, and the choice between rooted cuttings and scions. The greatest number of variations appeared after an irradiation dose of 1000 R; the higher mortality with higher doses reduced induced variants. In all, 57 variations were produced, which represents 0.81% of the irradiated material. Six variations were in the vegetative tissue, whereas the other 51 bud variations affected flower form and color. It was concluded that the most useful criterion for early determination of the optimum doses of x rays for induced mutants azaleas is measurement of the length of the shoots. The mutant plants and flowers of greatest interest are illustrated. (BBB)

12818 AN EXPERIMENT ON THE EFFECTS OF SEX-LINKED LETHALS IN HETEROZYGOUS CONDITION IN DROSOPHILA MELANOGASTER. Torroja, Eduardo (Consejo Superior de Investigaciones Cientificas, Madrid). Amer. Natur., 100: 77-80 (Jan.-Feb. 1966).

The experiment described utilized a new technique in which females carrying and not carrying sex-linked lethals in heterozygous condition competed in the same medium; males were introduced in every generation from the outside. Natural selection operates solely on the heterozygous level. Depending upon whether the heterozygosis for lethals increases or decreases the fitness of the flies, the frequency of the lethals should increase or decrease from generation to generation. Males from the Oregon R stock (isogenic for the X-chromosome) were given 4000 R of x rays, and crossed to virgin females from the Muller-5 stock. In the F_1 progeny, virgin +/M-5 females were isolated, and crossed in individual cultures to M-5 males. In the F_2 progeny the first 25 cultures which produced no + males, and therefore contained at least one lethal mutation in their X-chromosomes, were selected. The first 25 cultures which did produce + males, and consequently were free of sex-linked lethals, were also chosen. The two classes of genotypes, the relative frequencies of which were subject to competition and natural selection, were Muller-5/lethal and Muller-5/nonlethal females. In 3 of the 4 populations the proportions of the lethal-carrying females increased significantly for about 5 generations, and became stationary thereafter. The lethal-carrying X-chromosomes proved to be heterotic. What component of fitness contributed to this heterosis is not known; the competitive ability of the

larvae, the development rate from egg to the adult stage, the fecundity of the females, or a combination of these may be involved. (BBB)

12819 STUDY OF MUTAGENIC ACTIVITY OF A NEW GROUP OF CHEMICAL COMPOUNDS, AND THEIR GENETIC EFFECT WHEN COMBINED WITH IONIZING RADIATION. Sulkova, L. A. (Inst. of Biological Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 5, 739-43(Sept.-Oct. 1966). (In Russian).

Alkylating compounds K_{32}, C_{32}, and K_{16} proved to be active mutagens which are very promising for plant selection. The compounds were tested with respect to chlorophyll mutations in barley of the second generation after treatment (M_2). The mutagen K_{32} that yielded 16 to 41% of modified progenies appeared most active. It also showed a wider range of changes. The compound produced rare mutations—striata and tigrina—that did not develop under the action of the other mutagens used. In the two experiments described the frequency and range of mutations differed little. Since seeds of the same ear were used in both experiments, different results can be explained by various conditions under which they were performed. No distinct correlation was established in the combined action of chemical mutagens and radiation. The data differed in relation to the conditions of the experiment to be carried out. (auth)

12820 EXPERIMENTS ON THE MUTAGENIC EFFECT OF ^{222}Rn ON DROSOPHILA MELANOGASTER. Sperlich, Diether; Karlik, Anna; Pohl, Egon (Univ., Vienna). Strahlentherapie, 132: 105-12(Jan. 1967). (In German).

The mutagenic effect of radon 222 and its decay products was investigated. Male Drosophila were kept in a radon containing atmosphere. The percentage of the lethal mutations induced in the sex chromosome was determined. An increased mutation rate was found only, when the animals were kept for 24 hours in an artificial atmosphere with a Rn content of 78,600 nCi/l. A 24 hour exposure to 2800 nCi/l or a 21 day stay in the natural Rn-atmosphere of the mine in Badgastein/Böckstein (with 3.5 nCi/l) did not result in an increase. The last experiment shows, that there is no danger for the inheritance material of the human, even if he spends a prolonged time in the Rn-atmosphere of this mine. (auth)

12821 GENETIC VARIABILITY IN AEDES AEGYPTI (DIPTERA: CULICIDAE). III. PLASTICITY IN LABORATORY POPULATIONS. VandeHey, Robert C. (Univ. of Notre Dame, Ind.). Ann. Entomol. Soc. Amer., 57: 488-96(July 1964).

To assay the amount of hidden genetic variability in lab populations of A. aegypti, single mosquitoes were selected from cage colonies and inbred by single-pair matings to the F_2 generation. The F_2 progenies were examined for individuals showing structural variations. In addition to the analysis of naturally occurring genetic variability, an investigation was conducted to assay possible effects of radiation on genetic variability in A. aegypti. Adult male mosquitoes were irradiated with γ rays (13,000 R/min) from a ^{60}Co source. Three groups of mosquitoes were given doses of 2000, 3250, and 4000 R respectively. Each irradiated male was mated to a virgin female from the stock colony. Their progeny, whether male or female, was backcrossed to stock colony individuals. Thus visible mutations recovered in the F_1 or F_2 generations could be attributed to irradiation of a particular gamete. Variants were tested for heritability by further inbreeding unless they were phenotypically similar to mutants previously isolated. Consistent use of this criterion permitted an objective comparison of the frequency of mutations in different populations. The samples analyzed contained 52 pairs selected from 4 lab strains. Over 22,000 mosquitoes from 424 F_2 families were examined for morphological mutations. A total of 137 mutations was found in these samples. Fewer mutations were recovered from the irradiated material than from the controls. Moreover, the mutation frequency obtained at the higher doses (3250 and 4000 R) was lower than the frequency at 2000 R. However, there was an increase in lethality at the higher doses. Most of the visible mutations recovered from the irradiated material were similar in phenotype to those found in the controls. Only 3 mutations, half-genitalia, scale row, and bent wing were unique to the irradiated series. (BBB)

12822 EFFECTS OF ULTRAVIOLET RADIATION ON MAMMALIAN CELLS CULTURED IN VITRO. Antonelli, A.; Bacchetti, S.; Nicoletti, B.; Paggini, L.; Quattrocchi, R. (Univ., Rome). Atti Ass. Genet. Ital., 11: 223-5(1966). (In Italian).

Experiments were performed on Chinese hamster cells in vitro to test the ability of uv-light at 2650 Å and 2800 Å to induce cell death and chromosome aberrations. The results obtained show that the cell survival curve at both wavelengths is approximately sigmoid and that, in both cases, aberrations of the chromatid type are induced. The frequency of these aberrations as a function of time after irradiation decreases, for both treatments, after a maximum value probably related to the first post-radiation mitosis. Moreover, the effectiveness of the two radiations in respect to aberration production and cell death seems to be quite different: uv at 2650 Å more markedly affects the survival than does 2800Å, but induces a similar amount of chromatid damage (expressed as number of breaks per cell). Therefore either uv-induced death and chromosome damage is caused by two different actions, or the sample of cells killed is non-random with respect to chromosome damage. The fact that when the mitotic index is highest the amount of chromosome breakage is similar for the two treatments, suggests a lack of correlation between chromosome damage and cell death since all cells probably reach metaphase. (auth)

12823 DEFECTIVE ENDOSPERM, A RADIATION INDUCED MUTATION IN TRITICUM DURUM DESF.: CYTOLOGICAL, HISTOLOGICAL, GENETICAL, AND CHEMICAL ANALYSES. Avanzi, S.; Bozzini, A. (CNEN, Rome). Atti Ass. Genet. Ital., 11: 161-73(1966).

A mutant with defective endosperm induced in durum wheat by x-irradiation was characterized. Starch synthesis was less in mutant cells. Therefore cellular and nuclear degeneration were much less rapid and intense in the mutant endosperm than in the parent variety. The mutant line had a higher content of sugar at the expense of starch; fat and protein contents (in percent of dry weight) were similarly high. It is concluded that defective endosperm behaves as a monogenic recessive mutation involving metabolic changes in the plant as a whole that result in variations in kernel composition. (H.G.D.)

12824 CONSEQUENCES OF THE QUANTITATIVE CHARACTERISTICS OF THE TREATMENT OF SEEDS IN T. DURUM WITH X RADIATION HETEROGENEITY PHENOTYPES OF PROGENIES DERIVED BY TREATED AND NONTREATED SEEDS. Scossiroli, R. E. (Univ., Catania, Italy. Univ., Pavia, Italy). Atti Ass. Genet. Ital., 11: 147-60(1966). (In Italian).

In a population of Triticum durum, variety Cappelli, obtained from untreated seeds or from seeds x-irradiated with 2000 R, 4000 R, or 8000 R doses, all spikes were self-fertilized and classified at harvesting according to order of appearance on the F_1 mother plant. Observations of morphological and production characters in F_2 progeny showed a reduction of the means proportional to the irradiation dose applied to the seeds from which they were obtained. An independent reduction of the means is also found according to the order of appearance of the spikes on the F_1 plant, the earlier spikes being more affected. Such reduction effect is additive to the one induced by radiation particularly at the highest dose. Hence, a depression effect on means is demonstrated that is determined by some environmental effect, internal or external to the plant, effective on spikes produced in subsequent times, independent of chromosomal influences, and transmitted to the following generation. (H.G.D.)

12825 THE NATURE OF SPONTANEOUS MUTATION AND INDUCED IN ASPERGILLUS NIDULANS. Calvori, C.; Morpurgo, G. (Istituto Superiore di Sanita, Rome). Atti Ass. Genet. Ital., 11: 74-5(1966). (In Italian).

A method is described that permits the selection of forward and back mutations for a single cistron in Aspergillus nidulans controlling resistance to parafluorophenylalanine. One can distinguish external suppressors from true back mutations phenotypically. Utilizing this technique, the nature of spontaneous and uv, HNO_2 and methyl-bis chloroethylamine (HN-2) induced mutations were studied, in order to determine the rate of back mutation induced by the various agents. Most of the mutations induced by HNO_2 were not back mutable by HNO_2 itself nor by uv and were not generally suppressible by external suppressors. Therefore these changes were probably not base substitutions. Ultraviolet-induced mutations were for the most part uv, but not HNO_2, revertible and were generally suppressible. These changes probably were base substitutions. Mutations induced by HN-2 behaved in part as did those induced by HNO_2 and in part as uv-induced mutations. (auth)

12826 CYTOGENETIC ANALYSIS OF RECIPROCAL TRANSLOCATIONS BETWEEN X AND Y CHROMOSOMES OF DROSOPHILA MELANOGASTER. Arabia, L.; Canuti, N.; Tanzarella, C.; Nicoletti, B. (Univ., Rome). Atti Ass. Genet. Ital., 11: 237-40 (1966). (In Italian).

A cytogenetic analysis was made of 116 x-radioinduced reciprocal translocations between the X and Y chromosomes of Drosophila melanogaster for the purpose of extending the understanding of the genetic interactions between the two chromosomes. The characteristics of the sample are compared with those of 86 T(X;Y)'s described by Nicoletti and Lindsley in 1960. The present results generally confirm those of the previous analysis. The use of new stocks (a different irradiated X, a doubly, rather than singly, marked irradiated Y, and a balancer lacking an attached Y) produced a change in the incidence of T(X;Y)'s from 2 to 4.2% following 4,000 R. The 1960 samples were obtained using Y chromosomes

marked on the long arm only; thus T(X;Y)'s between the long arm of the Y, Y^L, and the proximal heterochromatin of the X, Xh, produced no linkage between the X and the Y markers, and were therefore unrecognizable. The present sample, making use of a Y marked at the end of each arm, $B^S Y y^+$, (Brosseau et al., 1961), contains 36 T (Xh;Y^L)'s. In the 1960 sample, Y^L was involved 2.3 times as often as Y^S. In the present sample, the factor is 1.5, in better accord with the metaphase arm ratio of about 3:2. In the smaller 1960 sample, X-chromosome breaks were equally frequent in the euchromatin and the heterochromatin, which suggested an accord with the ratio of metaphase lengths. In the present sample heterochromatic breaks were twice as frequent as those in the euchromatin, thus suggesting that metaphase length may be an inappropriate indicator of the probability of involvement in a rearrangement. The distribution of breaks along the euchromatin of the X appears random in the present analysis although in the earlier sample there was some indication of hot spots. The relative frequencies of lethals, T(X;Y)/Y steriles, and T(X;Y)/O steriles are not different from those in the 1960 sample. Among the 116 T(X;Y)'s, 23 were sterile as T(X;Y)/Y males. Of these, six were cyclical translocations of the type $Y^D X^P$; $A^D Y^P$; $X^D A^P$; confirming previous results. In addition, however, there were two cyclical T(X;Y; A)'s of the type $Y^D A^P$; $A^D X^P$; $X^D Y^P$; these were male fertile. These cases are interesting in connection with the relation, known to exist in Drosophila, between male sterility and X; autosome translocations. None of the 25 male-viable T(X;Y)'s with a euchromatic X chromosome breakpoint exhibited a variegated phenotype. Out of 82 T(X;Y)/Y viable cases there were however six T(X;Y)/O lethals, suggesting variegation for lethal genes. It is interesting to note, furthermore, that of the six cases of variegating lethals, four involved only heterochromatic breaks and may, therefore, represent a different class of position effect. (auth)

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Refer also to abstracts 12280, 12321, 12331, 12373, 12693, 12694, 12746, 12807, 12944, 12979, and 13002.

12827 (AD-639758) EXPERIMENTAL FAST NEUTRON DOSIMETRY AND LD 50/30 STUDIES IN MICE. Final Report. (Texas Nuclear Corp., Austin). Aug. 31, 1966. Contract AF 41(609)-2947. 53p. CFSTI $3.00 cy, $0.65 mn.

The report concerns experimental 14 MeV neutron dosimetry using mice as neutron scattering samples and an LD 50/30 study of mice using 14 MeV neutrons and 2 MeV x rays. The irradiations for the LD 50/30 study were carried out using computed neutron-flux-to-dose values. The experimental neutron dosimetry study is described, not only for mice but for three tissue-equivalent type materials: polyethylene, nylon, and Shonka plastic. (auth)

12828 (AE-255) DECONTAMINATION EXPERIMENTS ON INTACT PIG SKIN CONTAMINATED WITH BETA-GAMMA-EMITTING NUCLIDES. Edvardsson, K. A.; Hagsgard, S.; Swensson, A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1966. 35p. Dep. mn.

Results are summarized from a number of decontamination experiments performed on intact pig skin. In most of the experiments NaI in water solution was utilized because this nuclide was readily available, is easy to detect. Among the β-γ-nuclides studied ^{131}I has furthermore proved to be the one most difficult to remove from the skin. Results showed that a prolonged interval between contamination and decontamination has a negative effect on the result of the decontamination. Decontamination should be started as soon as possible after the contamination. Soap and water proved to be the most suitable decontamination agent. A number of other agents have appeared to be harmful to the skin. Soap and water, in connection with gentle rubbing, should be tried first for skin decontamination. No clear connection was demonstrated between the temperature of the water for washing and the result of the decontamination. Skin not degreased before contamination seemed to be somewhat easier to decontaminate than degreased skin, particularly if the activity had been on the skin for a long time. Irrigation of the contaminated surface with a solution containing the corresponding inactive ions or ordinary water in large quantities may considerably decrease the skin contamination. In radioactive work of long duration involving high risks of contamination, prophylactic measures in the form of a protective ointment may make decontamination easier. (C.H.)

12829 (CERN-66-34) RADIOACTIVITY INDUCED IN TISSUES BY 600 MeV PROTONS. Barbier, M.; Hutton, A.; Pasinetti, A. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 4, 1966. 63p. Dep. mn.

Beta and γ activities were determined theoretically and experimentally in mice exposed to 600 MeV protons. Activation analysis is applied to dosimetry of personnel involved in radiation accidents. (H.G.D.)

12830 (CEX-65.5) EXPERIMENTAL EVALUATION OF TECHNIQUES FOR IMPROVING FALLOUT PROTECTION IN HOME BASEMENTS. Summers, R. L.; Burson, Z. G. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). Oct. 1966. Contract AT(29-1)-1183. 126p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radiation measurements were made in the basement of an existing two-story wood frame house at the USAEC Nevada Test Site to evaluate and verify some simple and convenient techniques for improving fallout radiation protection in homes with basements. Fallout radiation was simulated by hydraulically pumping a sealed radioactive source of ^{60}Co at a uniform speed through tubing placed over the area of interest. Measurements were made by integrating ionization chambers. The protection factors ranged from 11 to 25 in the bare basement. Shielding the basement windows had very little effect on the protection. The overhead barrier technique provided the desired protection in the two-story house, but not for the simulated one-story house. The vertical position of the overhead mass is relatively more significant than its thickness. Consequently, using this technique would not achieve the desired protection for basements where a significant portion of the basement wall is exposed above ground. The small shelters and tilt-up shelter provided very good protection. The lean-to and tilt-up shelters were considered difficult to construct by unskilled labor. The sit-down shelter and workbench were considered easy. Household furniture stacked in one corner of the first floor provided only a small amount of increased protection in the same corner of the basement. Engineering calculations of the bare basement were about 30% higher than corrected experimental data for roof contributions, and up to 50% lower for ground contributions. The protection factors, derived from corrected experimental data, are expected to be accurate to within a standard deviation of ±8%. (auth)

12831 (CMN-Pub-2/65) BASES BIOLOGICAS DA RADIOISOTOPIA E NOCOES DE HIGIENE DAS RADIACOES. (Biological Bases for Radioisotope Use and Concepts of Radiation Protection). Rapp de Eston, Veronica; Eston de Eston, Tede; Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 129p. (In Portuguese). DTIE.

The basic concepts in the use of radioisotopes in medicine are reviewed in a series of articles on the somatic effects of radiation, radiation protection, maximum permissible levels, radiation detection, and radiation protection. Laboratory experiments to familiarize students with the use and dangers of radioisotopes are included. (J.S.R.)

12832 (CMN-Pub-4/65(Vol.2)) MANUAL DE HIGIENE DAS RADIACOES E PROTECAO RADIOLOGICA. (Manual of Radiation Hygiene and Biological Protection). Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Mediciinnnnna Nuclear). 1965. 180p. (In Portuguese). DTIE.

The second volume of the manual on radiation hygiene considers protection against x radiation, statistics of radioactive measurements and detection systems, radioactive fallout, and the consequences of exposure to radiation with a tabulation of the recommendations of the international commission on radiological protection. (J.R.S.)

12833 (CONF-651008-) PROCEEDINGS OF THE 11TH ANNUAL BIO-ASSAY AND ANALYTICAL CHEMISTRY MEETING HELD AT ALBUQUERQUE, NEW MEXICO, OCTOBER 7-8, 1965. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Sandia Corp., Albuquerque, N. Mex.). Contract AT(29-1)-789. 203p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared on eleven papers. Four papers were abstracted previously and appeared in NSA Vol. 20: as numbers 24, 3877, 6724, and 6725. (C.H.)

For abstracts of individual papers see: 12277-12280, 12746-12748, and 12834-12837.

12834 (CONF-651008-, pp 69-93) EFFECT OF CERTAIN CATTLE FEED ADDITIVES IN REDUCING RADIOACTIVE CONTAMINATION IN MILK. Gabay, J. J.; Dapolito, J. A.; Sax, N. I. (New York State Dept. of Health, Albany).

Strontium-90 and ^{131}I ingested in cows' milk present the greatest potential for internally deposited radioactivity in man in the United States. It is pointed out that the processing of milk through ion exchange resins, the barn feeding of cows using stored uncontaminated hay, or the utilization of canned or powdered milk in the event of radiological warfare would require technological readiness and add considerably to the cost of milk. Results are reported from tracer studies, using small groups of cows, on the effects of food additives on preventing the metabolism of ^{131}I and ^{90}Sr in cows. The food additives studied included a chelating agent, Verxite, a refined vermiculite, and sodium alginate, ob-

tained from seaweed or kelp. Results showed that the addition of Verxite to the diet prevented metabolism of ^{85}Sr by cows, but only if it was administered before and during the contaminating event, it also resulted in the excretion of large amounts of Ca, and did not prevent the metabolism of ^{131}I. The addition of pulverized rockweed (Ascophylum nodosum), which contains 28 to 32% algin, at a concentration of 5% by weight of grain intake, to the diet of cows caused a significant decrease in the amount of ^{131}I excreted in milk. The effect of alginate on the excretion of ^{85}Sr in milk was inconclusive, due to individual variations in cows, but it was concluded that this method of preventing the metabolism of Sr in cattle should be tested in larger groups of cows. (37 references.) (C.H.)

12835 (CONF-651008–, pp 168-82) LOCAL TISSUE DOSE FROM INSOLUBLE PARTICLES. Caldwell, Roger D. (Nuclear Materials and Equipment Corp., Apollo, Pa.).

Insoluble particles of α or β emitting radioisotopes do not deliver their energy throughout the critical organ but almost all the energy is deposited locally around the particle within the maximum range of the α or β radiation. Since many personnel exposures to airborne radioactivity are to micron size particles of insoluble oxides, titanates, or other compounds, it is important to know the local tissue dose from these insoluble particles. The effects of particle size on deposition in the lungs are discussed. A method is described for the calculation of the local tissue dose from deposited insoluble particles. The method was applied in calculations of the local tissue dose from spherical particles of $^{90}SrTiO_3$ deposited in the lungs or in transit through the gastrointestinal tract. A schematic illustration of the epithelium in the upper respiratory tract is included. Data are included on the specific ionization versus the energy for electrons in tissue, the β spectrum of ^{90}Sr, the β dose rate versus distance in tissue from the spherical particles of $^{90}SrTiO_3$, and the accumulated dose from $^{90}SrTiO_3$ particles deposited in the lungs or in transit through the gastrointestinal tract. The number of particles that would equal the ICRP recommendations on permissible occupational exposure to ^{90}Sr was also calculated. (C.H.)

12836 (CONF-651008–, pp 183) THE TRITIUM PROGRAM AT LAWRENCE RADIATION LABORATORY. Dupzyk, Isabelle A.; Dupzyk, Ronald J.; Silcocks, Harry L.; Wilcox, George E. (California Univ., Livermore. Lawrence Radiation Lab.).

Personnel occupationally exposed to tritium were monitored by liquid scintillation counting of urine samples. A computer program was developed for use in calculating the integrated dose received during single exposure incidents or continuous routine exposure. (C.H.)

12837 (CONF-651008–, pp 187-98) THORIUM AND ITS MPC'S. Heatherton, R. C.; Boback, M. W. (National Lead Co. of Ohio, Cincinnati).

Maximum permissible concentration (MPC) values for thorium as of 1965 are discussed from the viewpoint of an AEC contractor. Inconsistencies presently found in the official publications of the International Commission on Radiological Protection (ICRP), the National Committee on Radiation Protection (NCRP), and the USAEC are confusing and require clarification. In addition, it has been reported unofficially that the ICRP, in the next revision of its tables, will probably exclude or make more restrictive the provisional statement regarding the maximum permissible concentration in air (MPC)$_a$ for long-lived thorium isotopes. The authors feel that, in view of available information, such action by the ICRP is questionable and should be reconsidered. (auth)

12838 (LA-3583) RADIATION MEASUREMENTS OF THE EFFLUENT FROM THE NRX A-4 REACTOR. Larson, Oliver W.; Ahlquist, A. John; Henderson, Richard W. (Los Alamos Scientific Lab., N. Mex.). Aug. 1966. Contract W-7405-eng-36. 125p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of documentation studies on the effluent from the NRX A-4 EP-III, EP-IV, and EP-IVA full-power reactor tests are presented. Sampling procedures and equipment are described, and an analysis of the environmental effects due to the passage and deposition of the released radioactive material is given. (auth)

12839 (NP-16379) RADIATION EXPOSURE OF THE POPULATION DUE TO THE NORMAL OPERATION OF THE EUROCHEMIC REPROCESSING PLANT. Alderhout, J. J.; Franke, Th.; Hunzinger, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Oct. 1966. 30p. (ETR-197). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The average radioactive contamination in the air at ground level and the average rate of deposition on the ground have both been computed for a circular area of 100 km radius around the Eurochemic discharge stack. The estimate is based on the atmospheric discharges of radioactive nuclides expected to occur during normal plant operation, and on detailed observations of weather conditions in Mol during 1963. The area covers about half of Belgium, a large part of the Netherlands and a fraction of Western Germany. The radiation exposure of the population within this area has been calculated separately for all critical organs, taking into account all nuclides contributing significantly to the dose equivalent and all modes of exposure e.g., direct irradiation, inhalation, and ingestion of contaminated food stuffs. The resulting dose equivalents have been averaged over the whole population within this area taking into account the actual population distribution. In addition, separate figures are calculated for the population living in the vicinity of the plant, and for the Dutch and German populations involved. (auth)

12840 (NP-16410) ASSAY OF ^{90}Sr IN HUMAN BONE IN THE UNITED KINGDOM. Results for 1965, Part II. Monitoring Report No. 13. (Medical Research Council, London (England)). Aug. 1966. 18p. BIS $0.45. HMSO 2s, 3d.

Assays of strontium-90 in samples of human bone from subjects who died in the second half of 1965 are presented. The results obtained by the United Kingdom Atomic Energy Authority in the course of the national survey of the effects of radioactive fallout and the results of analyses carried out in Glasgow are reported. Results are tabulated. In accordance with prediction from the 1965 levels of strontium-90 in diet, the content of strontium-90 in the bones of the newborn was less in 1965 than in 1964. In infants and young children a decline might have been expected but is not yet apparent. On the other hand, in adolescents, where the rate of bone turnover is reduced, it takes several years for the bone to equilibrate with diet. The slight rise in strontium-90 content in adolescent bone in the IKAEA series is therefore much as predicted. The same phenomenon applies to adult bone. (H.L.W.)

12841 (NP-16470) CIVIL DEFENSE ASPECTS OF MUNICIPAL WATER SYSTEMS INCLUDING A PROTOTYPE SURVEY FORM TO PROVIDE INFORMATION ON A UTILITY'S PREPAREDNESS TO SUPPLY WATER IN THE EARLY POST NUCLEAR ATTACK PERIOD. (Engineering-Science, Inc., Arcadia, Calif.). Nov. 1966. Contract PH 109-66-15. 40p. CFSTI $3.00 cy, $0.65 mn.

The capability of a system to recover and continue to supply at least a minimum essential level of supply in the early post nuclear attack period is described. Information is developed on: General System, Consumers, Production and Consumption, Emergency Operation Plan, Emergency and Auxiliary and Personnel Inventory, Mutual Aid, Vulnerability, Water System Details, Emergency Water Supply and Distribution Requirements, Inventories and Records, Communications, Laboratory, Radiological Monitoring, Security, Postattack Operations, Water Utility Structures, and Miscellaneous (including instrumentation). (TSS)

12842 (NP-16536) APPROACH TO DEFINING POSTATTACK RECOVERY MANAGEMENT CONCEPTS AND TECHNIQUES. Clark, Donald E. Jr.; Miller, Carl F.; Hopkins, George D. (Stanford Research Inst., Menlo Park, Calif.) Nov. 1966. Contract OCD-OS-63-149. 61p.

Potential postattack countermeasures, under the six general categories of protective, radiological, medical, ecological, economic, and social, are listed and discussed briefly. A functional approach to the development of postattack recovery management techniques based on current knowledge is suggested, and present developmental limitations are indicated. (auth)

12843 (NYO-3364-28) LEVELS OF ^{137}Cs IN NORWEGIAN LAMB AND SHEEP, 1964–1966. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo). Contract AT(30-1)-3364. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are presented on the content of ^{137}Cs in sheep in Norway from 1964 through 1966. Samples from both adult sheep and lambs were analyzed. A decrease in ^{137}Cs content during this time was noted. (C.H.)

12844 (RM-5052-TAB) NUTRITION IN THE POSTATTACK ENVIRONMENT. Pogrund, R. S. (RAND Corp., Santa Monica, Calif.). Dec. 1966. Contract AT(04-3)-414. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Basic aspects of nutrition in the postattack environment were examined. Guardedly optimistic conclusions were drawn because of the following findings. The United States level of agricultural production per acre, for sufficient economic reasons, has not approached that achieved by some other countries. Thus, there is the potential for a considerable increase of production per unit of land if this is ever needed. The American diet is luxurious in its total calorie provisions, and in its use of animal products that are wasteful of primary calories grown on the land. Several options for increasing calories and essential nutrients are available postattack if land use has to be curtailed. Increasing use of seafood, elaboration of poultry production, and use of exotic food sources (algae, wildlife, etc.) were mentioned. Food storage, preattack, is feasible and further research is recommended re-

garding preservation techniques. Considerable emphasis was placed on recommending reliance on familiar foods in the postattack environment. The psychological problems created by the use of unfamiliar foods should not be added to an already disturbed population unless absolutely necessary on nutritional grounds. Further active research and development is recommended pertaining to all facets of the problem of postattack nutrition. There is much need for orienting the results of ordinary research programs on land use and food production to the specific problems of the postattack environment. (auth)

12845 (STI-DOC-10/58) BIOPHYSICAL ASPECTS OF RADIATION QUALITY. Technical Reports Series No. 58. Report of a Panel held in Vienna, 29 March–2 April 1965. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 188p. IAEA: $4.00; S 84,-; £1.4.0; F Fr 16,-; DM 14,-.

Separate abstracts were prepared on eleven papers. One paper was abstracted previously and appeared in NSA Vol. 19 as number 38873. (C.H.)

For abstracts of individual papers see: 12693, 12872–12875, 13014–13018, and 13363.

12846 RADIATION SHIELDING CONSIDERATIONS FOR INTERPLANETARY SPACECRAFT. Kottler, Carl F. Jr. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). J. Astronaut. Sci., 13: 133-52(July-Aug. 1966).

An analysis is made of the amount of protection against solar radiation required for astronauts during interplanetary missions. Calculations are presented of the radiation dose astronauts would receive when protected by various combinations of passive shielding, as a function of mission duration and the probability of exceeding the statistically predicted dosage of the NASA Model Solar Proton Environment. Doses to the internal organs and the skin (taking into account self-shielding) are determined as a function of the energy of the incident particles, and are compared with permissible doses. The shielding and associated effective cutoff energies required for protection against α particles and protons are calculated for mission durations between 1 week and 2 yr, with 3 probabilities of exceeding the indicated doses (0.1, 0.01, and 0.001). The manner of presentation of the data readily permits comparison between magnetic or electrostatic shielding and passive shielding on the basis of radiation dosage and mission duration. Parametric curves for typical aluminum structure, polyethylene shield, hydrogen-fueled spacecraft are shown. An introductory description of the solar atmosphere, solar activity, and associated geomagnetic phenomena is also presented along with numerous reference tables. (BBB)

12847 DEVICE FOR LIMITING HARMFUL IRRADIATION IN ROENTGENOSCOPY. Nesis, A. I. Vestn. Rentgenol. Radiol., 39: 70-1(Mar.-Apr. 1964). (In Russian).

A device was designed to completely prevent the exit of the direct beam of x rays beyond the limits of the glass of the fluoroscopy screen. The mechanism functions with the help of a simple beam-limiting device. (TSS)

12848 RADIOPROTECTION TECHNIQUE. Drexler, G.; Goettel, K. (Institut fuer Strahlenschutz der Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). Radiologe, 6: 327-31(Aug. 1966). (In German).

The degree of attenuation of x radiation is one appropriate measure for the evaluation of shielding. The radiation attenuation properties of Pb are illustrated. Attenuation factors for Pb for x-ray tube voltages of 100 to 300 kV are plotted for Pb thicknesses from 0.5 to 7.5 mm. Two examples of calculation of shielding required are worked out from tabular data presented. Protective values for Pb clothing are tabulated. (TSS)

12849 RADIONUCLIDES IN MILK. Campbell, J. E.; Murthy, G. K.; Lewis, K. H.; Straub, C. P. (Robert A. Taft Sanitary Engineering Center, Cincinnati). pp 156-79 of Radioactive Fallout Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

Results are presented of monthly sampling of raw milk from selected portions of 10 milksheds serving major population areas in the U.S. Each sample was analyzed for Ca and K content, ^{131}I, ^{140}Ba, ^{137}Cs, ^{89}Sr, and ^{90}Sr. The data reflect the effects of nuclear testing and climatological, meteorological, and geographical variations on radionuclide levels in milk, as well as the effects of farming practices. A direct relation was observed between weapons tests and the occurrence of ^{131}I, ^{140}Ba, and ^{89}Sr in milk. The concentration of these radionuclides was influenced by their half-lives and meteorological conditions affecting the fallout pattern. The presence of ^{90}Sr and ^{137}Cs in milk was independent of weapon tests. This concentration is influenced by several factors which include the residence time of these radionuclides in the stratosphere, meteorological conditions influencing deposition, total amount deposited, and seasonal changes in feeding practices. A marked increase in the radionuclides was consistently observed during spring and early summer, which was associated with the changes in feeding practice. This was more apparent in the northern part of the United States than in the South. Average ^{137}Cs levels in milk paralleled the ^{90}Sr levels during periods of active fallout, but were much lower during periods of no tests, because, once localized in the soil, Cs is translocated much more slowly to the aerial portions of plants through the root systems than is ^{90}Sr. The single monthly sampling method compared favorably with the monthly composite for ^{137}Cs and ^{90}Sr. (BBB)

12850 EXPOSURE OF HUMANS TO THE NATURAL AND ARTIFICIAL RADIATION. Seelentag, Walter; Schmier, Herbert (Bundesgesundheitamt, Berlin). Radiologe, 6: 303-10(Aug. 1966). (In German).

Because of the lack of adequate knowledge about the effect of very small doses of irradiation the normal exposure to radiation can be a significant measure for the importance or inconsequence of additional irradiation exposure. Additional irradiation exposure that is of the same order of magnitude as the normal variations of environmental irradiation can be regarded as acceptable. In Germany there is an average natural basic radiation exposure of humans that amounts to ~100 mrem/yr, with a range of variation between 70 to 200 mrem/yr, estimated for whole-body and gonads. From $\frac{1}{4}$ to $\frac{1}{3}$ of this exposure arised from cosmic radiation, ~$\frac{1}{2}$ from environmental radiation, and ~$\frac{1}{4}$ comes from exposure to radioactive materials incorporated naturally. At present, the exposure due to man-made radiation sources can be estimated to be ~40 to 50% of the natural radiation. This exposure is equally divided between radiation exposure of patients to x-ray diagnostic procedures and fallout from atomic weapon tests. As far as the significance of the diagnostic exposure is concerned, it will continue or even increase in the coming years, while the exposure from fallout will decrease gradually. At present, the occupational exposure of persons engaged in radiation work and with small sources of radiation account for only a few % of the radiation exposure of humans. (BBB)

12851 OVERDOSES FROM LINEAR ACCELERATOR. Lancet, 2: 212-13(July 23, 1966).

On Feb. 11, 1966, a fault in the control system of the 8-Mev linear accelerator at Hammersmith Hospital caused an overdose to be given to three patients undergoing electron-beam therapy. The effects on two of the patients were severe; in the third case, slight. The committee of inquiry did not report on the condition of the patients or the illnesses for which they were being treated, but the two severely affected patients are still hospitalized. The inquiry disclosed that the coincidence of two rare events led to the failure of a control system that had operated without mishap since 1958. The output of the electron gun which feeds the accelerator is controlled by varying the current through its filament, but the variations required are normally very small. The radiographers are not permitted to alter the filament current by more than a slight amount, except after a new filament has been fitted (which is about once a year), when for 3 or 4 days a higher current is needed to give the same output from the accelerator. That was the situation on Feb. 11, when there was also a partial failure in the dosemeter which monitors the electron beam emerging from the accelerator. If the failure had been total (as it usually is when a dosemeter goes wrong), it would have been noticed at once. A transient fault in a capacitor produced a false low reading in the dosemeter, and the radiographers raised the filament current still further, thus causing the overdoses. The hospital staff has now formulated a revised code for working the accelerator. The figures relating filament current to radiation dose were not well known, and in the committee's view, the figures should be widely publicized among users of linear accelerators, who should know, for example, that the max dose the machine can give is about 70 times the normal operating dose. (BBB)

12852 CATASTROPHE AND WAR DOSIMETRY ("K-DOSIMIMETRY"). Wachsmann, F.; Kimberger, F. (Univ., Erlangen, Ger.). Radiologe, 4: 372-4(Nov. 1964). (In German).

The purposes of K (Kreig) dosimetry include measurement of dose rates to ascertain fallout shelter occupation time and measurement of personnel doses to evaluate the necessity for protective measures and treatment to minimize radiation injuries. The reasonable max dose established for catastrophe is 12.5 rem. This amounts to 310 mrem/hr. This value can be exceeded if human life is endangered. The smallest dose of interest in K-dosimetry is ~5 rem for catastrophe and 25 rem in military usage. These doses should cause no symptoms after a single exposure. The major peacetime source of a possible radiation catastrophe is reactor operation, but incidents of this type are fortunately very infrequent. Requirements for dosimetry during wartime are much more complex and require numerous considerations, such as nondirectionality, dose-rate independence, long-term storage

capability, reuseability, accuracy, mechanical and chemical resistance, open or covered indicator, central or decentralized evaluation facilities, indication of dose, supply, etc. At present, there is no dosimeter that satisfies all requirements. The first and oldest one available is the film dosimeter. This has the advantage that it can be evaluated at decentralized facilities. The glass dosimeter has advantages that include durability, long-term dose storage, and multiple usage. However, it requires complicated and expensive evaluation equipment, usually located at a centralized site. Chemical and biological methods of dosimetry are incompletely developed at present. (BBB)

12853 PROTECTING THE IRRADIATED LENS. Fenske, H. D. (Andrews Air Force Base, Md.); Leinfelder, P. J. Amer. J. Ophthalmol., 61: 1432-4(June 1966).

The long-term effects of a high dose of ionizing radiation on the rat lens were examined, with emphasis on modified response through the use of partial shielding. Each exposure was 3000 R delivered at 414 R/min with a 250-kv x-ray source. Partial shielding was accomplished by inserting a half-oval lead corneal contact lens under the eyelids. Two months following irradiation of the whole lens a complete cataract was observed. There was extensive radiation effect on the lids, conjunctiva, and cornea, and no evidence of recovery from cataract. Neither a partial nor complete cataract was observed in the half-shielded rat lens 12 months following irradiation. No radiation effects were observed on the lids, conjunctiva, or cornea. Thus, transparency of a rat lens is maintained after an overwhelming exposure to x radiation by shielding half of the lens. Arcuate opacity was not seen in the small rat lens, as described in the rabbit lens, which may be the result of size rather than an absence of partial opacification. Following irradiation of the half-shielded rat lens there was a precise zone of modified epithelial cell damage similar to that described in the rabbit lens. The number of damaged cells and size of the damaged area decreased as time progressed. The modified response in the shielded lens was seen immediately following irradiation and continued throughout the experiment. With time a narrow cord of pathologic epithelial cells was sharply outlined between normal-appearing epithelial cells. Prevention of formation of a complete cataract in the rat lens may result from recovery of the lens epithelium with the formation of normal lens fibers. Multiplication of the unirradiated epithelial cells occurs in the irradiated area, with differentiation into normal lens fibers. It is believed that, as the abnormal epithelial cells decrease, there are fewer pathologic lens fibers formed and fewer cataractous changes. (BBB)

12854 DETECTION OF RADIOACTIVE CONTAMINATION OF FOODSTUFFS OF ANIMAL ORIGIN IN STATE VETERINARY INVESTIGATION CENTERS. Wegener, K. H. (Bundesininisterium fuer Gesundheitswesen, Bad Godesberg, Ger.). Zentralbl. Veterinaermed., 12: 629-32(Dec. 1965). (In German).

State veterinary investigation centers should have the capacity to carry out measurements of radioactive contamination of meat and other animal foodstuffs. In order to do this they should be supplied with adequate instrumentation. This would include a multichannel analyzer, low level counter, proportional counter, etc. Supervision of foodstuffs is a legally established function, and it is particularly important to study questions that relate to transmission of radioactive materials incorporated into animal tissues to man. The veterinary investigation centers are responsible for studies of these factors and as sources of expert opinions on the conditions of environmental radioisotope hazards in animals. Centers of this type would also be valuable in times of emergency when radioactive contamination of foodstuffs would be even more of an immediate hazard. (BBB)

12855 MEDICAL ASPECTS OF SPACE FLIGHT. Douglas, William K. (Andrews Air Force Base, Washington, D. C.). Int. Surg., 45: 532-8(May 1966).

Problems encountered in manned space flight which are surveyed here include those associated with acceleration, weightlessness, and ionizing radiations. As one means to prevent astronaut irradiation, the Van Allen belts can be avoided by staying beneath them for earth orbiting missions or by traversing them rapidly, thus holding the time of exposure to acceptable limits for missions beyond near-earth space. Also considered are cosmic rays and the radiation which accompanies solar flares. Cosmic rays are of such high energy, that it is almost impossible to provide shielding against them; an equivalent protection in space to that given by the earth's atmosphere would require nearly 30 in. of lead shielding. These high energy rays are relatively rare, and measurements taken in satellites indicate that they will probably not pose a great threat to the astronaut's health. Solar flares are of greater concern. This radiation is released by the sun at the time of so called solar storms, and methods are being perfected to forcast the sun's weather so that it may be possible to avoid flying during periods when solar storms are predicted. Other approaches include the provision of so-called foxholes of shielding in which the crew could remain during these periods. Antiradiation drugs also offer some protection, and if perfected would be of great benefit to space research. (BBB)

12856 RADIONUCLIDES IN MILK AND MILK PRODUCTS. Allen, R. S. (Iowa State Univ., Ames). J. Dairy Sci., 49: 899-900(July 1966).

How milk and milk products serve as major routes of radionuclide contamination in man, particularly in children, is discussed. Isotopes considered to be most hazardous in milk include ^{131}I, ^{90}Sr, ^{140}Ba, and ^{137}Cs. In a study of milk from cows in Utah, Minnesota, and Iowa, ^{131}I levels up to 710 pC/l occurred in cows on pasture, whereas those on stored feed had levels less than 60 pC/l. Levels of milk ^{131}I decreased rapidly after animals were removed from pasture. This study also showed that ^{131}I was transmitted to the milk only when contaminated (by fallout) feedstuffs were consumed. Since ^{131}I has a short half-life (8 days), a storage period of 45 days allowed time for nearly all the ^{131}I with the roughage to disappear. Should a nuclear attack occur, ^{131}I levels in milk could be of such magnitude to become serious during the first few weeks. Thereafter, the hazard decreases quite rapidly, because of radioactive decay. The hazards of ingestion of ^{90}Sr, ^{140}Ba, and ^{137}Cs in milk are less than those from ^{131}I. Marked reduction in milk consumption could be more of a health hazard than irradiation effects resulting from milk containing low levels of these isotopes. Levels of ^{90}Sr and the other radionuclides can be kept low by feeding roughages that have been under storage prior to fallout. (BBB)

12857 SUR-PAK AND PHYSICAL RADIATION PROTECTION SURVEY OF DENTAL X-RAY EQUIPMENT IN MAINE. Garcelon, Alonzo H. (Maine Dept. of Health and Welfare, Augusta); Miller, James W.; Campbell, Elmer W.; Fuller, James W.; Hoxie, Donald C. J. Maine Med. Ass., 57: 103-10(June 1966).

Recommendations are made by which dentists can reduce radiation exposure of patients and personnel in dental radiography. Also, the results of a combined Sur-Pak and physical survey of dental radiographic practices recently conducted in Maine are reported. The purpose of this survey was to provide x-ray film packs to be used in the step-wedge method for the assessment of filter needs and also to show beam diameters and collimator needs. (TSS)

12858 RADIOLOGICAL SAFETY IN DENTISTRY. PART II. Pentel, Leon (New York Univ., N. Y.). N. Y. J. Dent., 36: 240-9(Aug.-Sept. 1966).

Scattered radiation levels in a dental office were determined by a dosimeter survey, and ways to avoid undue exposure from this source are suggested. An ionization chamber type ratemeter held behind and to one side of the tube head at the instant of exposure was deflected off the 2.5 R/hr scale at the onset of exposure of 70 kVp and 10 ma, indicating a flux in excess of the capacity of the instrument. This high hourly rate is considered in terms of the 30.75 sec used for actual exposure of a 19-film series dental examination. Experiments demonstrated the existence of a widespread zone of scatter and reflection, as a result of the interaction of the primary radiation energy within the patient. This delivers a dose of greater magnitude than the reflection and scatter from the radiological examining room. Methods for improving radiation safety practices in the dental radiographic installation are discussed. (TSS)

12859 RADIOLOGICAL SAFETY IN DENTISTRY. PART I. Pentel, Leon (New York Univ., N. Y.). N. Y. J. Dent., 36: 206-12 (June-July 1966).

The extent of exposure of patient and dentist in intraoral radiography is assessed and means of reducing this exposure are presented. The dose used in dental practice is, in general, large when compared with the medical dose in average routine procedures. Specifically, a 2 R dose is delivered to the skin in a single molar radiographic exposure using medium speed film (radiatized) emulsion and 65 kVp, whereas a single chest plate exposure delivers about 50 to 250 mR to the skin. The dental dose for a single film thus exceeds the medical dose by a possible factor of 10. A single film is generally used in average medical procedures, while dental procedures usually require many exposures of a single magnitude. Further, the medical radiation energy is used at a higher kVp, which compared to the dental energy, provides a shorter wavelength x-ray photon, of more penetrating and less absorptive quality. The hazards of scattered radiation, in particular, are mentioned. Various radiobiologic concepts are reviewed. (BBB)

12860 SAFETY IN THE CHEMICAL LABORATORY. XXV. LASER LABORATORY DESIGN AND PERSONNEL PROTECTION FROM HIGH ENERGY LASERS. Goldman, Leon; Hornby, Peter (Children's Hospital Research Foundation, Cincinnati). J. Chem. Educ., 43: A335-46(Apr. 1966).

Lasers operated in the Q-switched mode can now generate power

outputs as high as gigawatts. With the generation of second and fourth harmonics, laser generation in the uv range is now possible. With such significant energy and power outputs, it is obvious that personnel working with lasers must be protected. The protection program described centers about the following design and operational features: (1) personnel control; eye, exposed skin, and inhalation; (2) area control; avoidance of spectral reflectance, proper ventilation, and avoidance of electrical shock. It is not always possible to separate rigidly the personnel control and area control, but the distinction is made to emphasize the need for the development of special laser laboratories, rather than the use of laser equipment in any available lab space. Accidental premature discharge of the flash lamps, particularly as the flash lamps become well used, can occur; therefore, a strict rule of operation should be that all work on the laser benches stops with the advent of the warning lights. Full protection of the eyes means shielding not only from impact of the direct beam but also from the significant amount of reflection from surfaces. Eye protection is divided essentially into the following phases: (1) design of closed laser systems; (2) avoidance of highly reflectant surfaces on and adjacent to the target areas; (3) personnel protection in the form of protective devices for the eyes; (4) constant reappraisal of all proposals for area and personnel protection; and (5) continued eye examinations and records for all operating personnel. (BBB)

12861 RADIATION DOSAGE, DOSAGE UNIT, AND DOSAGE DETERMINATION. Kossel, F. (Institut fuer Wasser-, Boden-, und Lufthygiene, Berlin). Roentgenpraxis, 18: 179-84(Aug. 1965). (In German).

The factor expressing dose for soft tissues is relatively constant for almost all voltages. In bone the effects of irradiation are much greater and vary extensively with radiation energy. With increasing voltage, the energy absorbed also decreases, and the difference in absorption between soft tissues and bone becomes less. This reduces the ability to differentiate between these tissues in x-ray photography, while to obtain more uniform dosage in x-ray therapy high voltages are used. The relative biological effects (RBE) of various types of radiation are: for x, β, and γ radiations, 1; for fast neutrons, protons up to 10 MeV, and α particles, 10; and for heavy nuclei, 20. (BBB)

12862 IMPROVED SCHEEL TYPE GRIDS. Watson, W. Radiography, 31: 105-10(May 1965).

Reduction of patient exposure by use of modified grids is explained. A conventional radiographic grid requires an increase in patient exposure due to a degree of absorption by the grid of primary image-forming radiation and to an absorption of scatter. Some of the primary rays are totally absorbed by the body tissues and some of the image-forming rays are completely absorbed by the lead slats. The totally absorbed rays produce scatter but no primary image on the film and therefore should be eliminated before reaching the incident surface of the subject. This can be achieved by placing an additional grid on the tube side of the patient, but this grid must be an exact copy in a reduced form of the pattern of the distal grid, and both grids must move at proportionate speeds so that their images always coincide. To do this with modern fine grids, or even with a coarser type, presents a problem which is simplified by the adoption of a principle first described by Scheel. The Scheel principle is explained, as well as construction of improved grids. Compared with the conventional type of single grid the complexity of the double grid technique may be objectionable, but the one vital factor in its favor is reduced patient dosage. Another factor is low cost of manufacture. (BBB)

12863 PROTECTIVE EFFECT OF CYSTEINE ADMINISTRATION ON THE LOWERING OF RESISTANCE TO BACTERIAL INFECTION INDUCED BY X IRRADIATION. Sakakibara, Toshihiko; Miyamoto, Shuzo; Aizawa, Ken; Nagoya, Toshikatsu; Toshioka, Teruo (Nihon Univ., Japan). Hoshasen Igaku Seibutsugaku, 2: 23-48(1965).

Mice receiving a dose of ten to thirty mg of cysteine hydrochloride at various time intervals before whole-body x irradiation showed a prolonged survival time, and the survival was proportional to the dose of cysteine administered. When the cysteine was given within one hour before x irradiation the effect was most beneficial. Whole-body x irradiation of mice stimulated the infection with pneumococci to become very active resulting fatal bacteremia. Pretreatment with cysteine 30 min before x irradiation protected the animals against fatal infection. Similar experiments were conducted using Salmonella typhimurium and Pseudomonas aeruginosa. Evidence indicated that bacilli in the blood showed a marked fall in numbers about 12 hours after infection. (H.L.W.)

12864 PRINCIPLES AND UNITS IN RADIATION MEASUREMENTS: A SHORT REVIEW. Schinz, H. R.; Wideroee, R. (Univ., Zurich). Indian J. Radiol., 18: 61-3(May 1964).

Difficulties and confusion regarding radiological measurements and their interpretation are discussed. To complete and clarify the system of measurements, a new special unit, the Planck (1 Planck = 3000 erg/cm^2), is proposed for the energy fluence of the radiation field. (TSS)

12865 PHOTOGRAPHIC DOSIMETRY: GAMMA CALIBRATION. Olivares Munoz, M. P. (Hospital de San Juan de Dios, Madrid). Acta Oncol. (Madrid), 4: 78-100(Jan.-June 1965). (In Spanish).

The principles of dosimetry using photographic emulsions are extensively explained, and applied to a ^{60}Co beam used for radiotherapy. Characteristic curves are illustrated for various types of films exposed to a ^{60}Co source at a dose rate of 12 R/hr and a distance of 40 cm. The shape of the characteristic curve (optical density vs dose in mR) was similar for the various makes of film, it having an exponential form in all cases. For comparison, some characteristic curves were made using radium as a source. The optimal conditions for using film dosimetry to calibrate radioactive sources are outlined. (BBB)

12866 RADIATION ACCIDENTS: THE PUBLIC'S RIGHT TO KNOW. Longood, Robert J. (New York State Dept. of Health, Albany). Amer. J. Public Health, 56: 1751-5(Oct, 1966).

Two incidents in which the public was potentially exposed to missing radiation sources are cited to illustrate the way in which press officers may deal with news releases of such accidents. Reasons are given for presenting a frank, honest account of such incidents to the public. Problems encountered by press officers in handling news media reporters in these situations are also dealt with. (TSS)

12867 LEGAL SOURCES OF RADIOPROTECTION. Pfaffelhuber, Josef (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg, Ger.). Radiologe, 6: 338-42(Aug. 1966). (In German).

The legal background on which the authority of the German Federal Republic is based to control and regulate use of atomic energy and radioisotopic drugs is discussed. These laws as issued control the limit of tax-free income for nuclear fuels, precautions, import and export of radioactive materials, general licensing exemptions, and licensing of various types of construction. The degrees to which various portions of the legal regulations overlap, as between the Federal Republic and the several states, and the respective legal powers of each unit to regulate the licensing and use of atomic energy and radioisotopes are outlined briefly. Other legal considerations that affect use and distribution of radioisotopes are defined and evaluated. (BBB)

12868 RADIOISOTOPE FACILITIES IN THE GENERAL HOSPITAL. Ingraham II, Samuel C.; Barnett, Mark; Taylor, Wilbur R. (Public Health Service, Washington, D. C.). Mod. Hosp., 105: 112-15(Nov. 1965).

This report gives guidelines for planning and operating two radioisotope facilities: one for hospitals anticipating relatively simple diagnostic tests and the other for hospitals anticipating diagnostic tests, diagnostic scanning procedures, and occasional intracavitary therapy. The design and techniques outlined should be of assistance to architects, planners, and administrators in building and maintaining safe, efficient isotope installations. To protect personnel against the radiation from externally located radioactive materials, shielding should be provided where necessary. The most important factor in protection against the internal hazards of radioactive materials is the prevention of their ingestion or inhalation through safe operating techniques. A description of the general kinds of activities performed in the radioisotope department provides some information of the space and equipment required. Two suggested plans show the relation between the workload and facilities required. (TCO)

12869 INTEGRAL DOSE MEASUREMENT IN ROUTINE INTRA-ORAL RADIOGRAPHIC PROCEDURES. Murai, Takeo; Sasaki, Takehito; Inomata, Hiroshi; Hitomoto, Tamotsu (Tokyo Medical and Dental Univ.). Bull. Tokyo Med. Dent. Univ., 10: 523-31(Dec. 1963).

The radiation hazards to patients undergoing dental radiographic procedures are considered. Most previous reports have concerned the skin doses in dental radiographic procedures, the skin dose per exposure in the intra-oral radiographic procedures ranging from 0.2 to 1.0 R according to the region to be exposed. However, it is desirable to take into account the integral dose and gonad dose to evaluate better the effect of radiation on the exposed patient's body. The Murai method, in which the integral dose is measured by use of a plastic scintillator phantom, was used for the measurement of the integral dose in a routine intraoral radiographic technique. In intra-oral radiography of the maxillary molar region, the integral dose was estimated to be about 100 g-R per exposure. The integral doses obtained by these measurements substantially agreed with those obtained by a different method by Ardran and Crooks (Brit.

J. Radiol., 32: 572(1959)). In a routine full-mouth intra-oral radiography about 10-sec exposure time is needed in all exposures; then the total integral dose in the patient is estimated to be about 2000 g-R. From the viewpoint of radiation protection, it is desirable to reduce the integral dose, i.e., smaller field size and thicker filtration are preferable. However, too small field size and too much added filtration may cause the repeated exposure of the patient because of faults in the radiograph due to cone cutting and blurring. (BBB)

12870 THE INTEGRAL ABSORBED DOSE IN CONVENTIONAL AND PANORAMIC COMPLETE-MOUTH EXAMINATIONS. van Aken, J.; van der Linden, L. W. J. (Univ. of Utrech). Oral Surg., Oral Med., Oral Pathol, 22: 603-16(Nov. 1966).

Information was obtained on the integral absorbed dose received when the following techniques are used: conventional complete-mouth x-ray examination, panoramic examination with the Panoramix (intraoral x-ray tube), and panoramic examination with the Orthopantomograph. Conventional and panoramic complete-mouth x-ray examinations are so different that a comparison of the amount of radiation administered to the patient cannot be made with the use of exposure measurements in R. The integral absorbed dose (total amount of energy absorbed by the patient and expressed in gram rads or ergs) is more suitable for this purpose. This dose was determined by measuring the amount of energy passing through a cross section of the x-ray beam before entering the patient. The integral absorbed dose for a complete-mouth examination with 2 different conventional techniques was 700 and 1300 g-rad. It was shown that, for the conventional technique, an increase in the kVp value reduces the amount of radiation that the patient receives, but not as dramatically as the skin exposure suggests. Examination by the panoramic technique with the Orthopantomograph delivers 110 g-rad to the patient, whereas 19 g-rad is administered during examination with the Panoramix. These findings emphasize the need to consider new techniques when selecting a technique for a complete-mouth examination. (BBB)

12871 EARLY REGULATORY EFFORT (1930–1945). Kleinfeld, Morris (New York State Dept. of Labor, N. Y.). Ind. Hyg. Rev., 6: 15-23(Dec. 1964).

Steps in the development of the New York State radiation safety program are traced. The program now provides for the following requirements: all radiation sources, other than those specifically exempted, should be licensed by or registered with the agency of jurisdiction; all installations and sources should be inspected regularly; radiation sources should be under the control of competent operating and safety personnel, and employees instructed in safety precautions; radiation exposures of workers should be monitored to assure that the permissible levels are not exceeded; radiation hazards should be properly surveyed and evaluated; records of individual exposures, radiation surveys, receipt and disposal of sources, and other pertinent data should be properly maintained; hazardous areas should be posted and radiation sources labeled, and the state agency of jurisdiction should be notified promptly of all radiation accidents. In the past 8 years, there have been 13 incidents of overexposure to radiation involving 72 workers in industry in New York State. Thirteen sustained radiation injury mainly to the hands, and only 2 of 22 exposed to significant concentrations of radioactive materials showed a retention of this material by the body, in both instances, in small amounts. The safety record of this industry, as demonstrated by the accident, injury, and compensation data of the federal government and of New York State indicates that the industry is one of the safest. The benefits arising from the proper use of radiation far outweigh its potential risks. (BBB)

12872 RELATIONSHIP BETWEEN PRIMARY ENERGY TRANSFER AND TARGET THEORY. Oda, N. (Univ. of California, Berkeley). pp 165-83 of STI-DOC-10/58.

The statistical nature of primary energy transfer, and the propagation of the statistical nature of primary energy transfer to subsequent processes, and the sequence of reactions that are involved in deriving radiation dose effect function for both low LET and high LET radiations are discussed. Recent progress in studies on the mechanisms of radiation effects is reviewed. The applicability of the purely statistical approach inherent in target theory for the calculation of sensitive volume is discussed and it is concluded that the conventional interpretation of target theory is incompatible with experimental evidence of the energy transfer process and the effects of modifying agents such as temperature, environmental gas, and physiological state of the organism. An attempt is made to modify the interpretation and the expression of the conventional target theory, while preserving its statistical character of primary energy absorption process, so that it can coexist with apparently contradictory experimental results, and in addition, be useful in gaining an insight into the mechanisms of radiation effects on biological systems. Formulae are presented for relating primary energy transfer to subsequent processes. An illustrative chart is included for relating the dose-effect function and relating variables to the whole sequence of reactions induced by radiation in biological systems. (C.H.)

12873 ANALYSIS OF DOSE–EFFECT RELATIONS. Kellerer, A. (Univ., Munich). pp 95-114 of STI-DOC-10/58.

The basic characteristics of radiation dose-effect curves are discussed. It is pointed out that the radioinduced inactivation of biological systems may be affected by biological variability, the random nature of radiation energy deposition, and the stochastic nature of vital processes. The influence of the number of interacting absorption events, the diameter of the sensitive site, and local radiation energy density on dose-effect relations is discussed. Data on the inactivation of mammalian cells in vitro with ^{60}Co γ radiation and x radiation led to the conclusion that for inactivation with low LET radiation it is necessary that more than four absorption events interact in a sensitive region of at least 1 μm diameter. The concept of local radiation energy distribution and applications in the establishment of dose-effect relations are discussed. A comparison of experimental and theoretical data led to the conclusion that the true curve of radiation dose-effect should lie between the experimental and theoretical curve. (C.H.)

12874 LET DISTRIBUTIONS AND THE INFLUENCE OF VARIOUS PHYSICAL FACTORS IN MODIFYING RADIATION DAMAGE. Cormack, D. V. (Univ. of Saskatchewan, Saskatoon, Can.). pp 127-40 of STI-DOC-10/58.

Linear energy transfer (LET) is used to describe the spatial distribution of energy deposition along a short portion of a charged particle track that initiates biochemical and biological events in biological systems. The concept of LET does not take into account the statistical fluctuations in the quantity of energy locally imparted in the track segment nor of the combined effects of more than one track. A specific value of LET can be assigned only to a monoenergetic beam of particles that traverse a sample so thin that their energy does not change appreciably in passing through it. The particle fluence distribution or LET distribution may be presented in a number of forms and various investigators have used different basic LET data in calculating the distributions. A method for the calculation of LET distributions is presented and the assumptions used in the calculations are defined. Data are presented from calculations of the LET distribution for electrons generated in water by ^{60}Co γ radiation, the LET distribution of the electrons generated by the bremsstrahlung from a 25-MeV betatron, the LET distributions for electrons generated by 250-kVp x rays, the LET distribution for electrons generated by 50-kVp x rays, and the LET spectra of heavy ion beams with a velocity corresponding to 100 MeV per nucleon or 10 MeV per nucleon. Data are tabulated on the track average and dose average LET for a number of radiations. The effects of oxygen tension, water content, and protective chemical agents or variations of RBE with LET are discussed. Results are reported from studies on the effects of humidity and pretreatment with inositol on the sensitivity of diploid yeast to x radiation and on the effects of humidity, oxygen, and inositol on the sensitivity of Serratia marcescens to x radiation. A pronounced drop in radiosensitivity was observed when the humidity was reduced. Possible reaction mechanisms involved are discussed. (C.H.)

12875 METHODS FOR DETERMINING THE DISTRIBUTION AND QUALITY FACTORS OF PENETRATING RADIATION FOR LET. Lebedev, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 155-65 of STI-DOC-10/58. (In Russian).

The biological dose of radiation and the radiation hazard associated with it can be accurately determined if the absorbed dose and the relative biological effectiveness (RBE) of the radiation are known. The absorbed dose is a purely physical quantity and can now be determined with a sufficient degree of accuracy by widely differing physical methods. The coefficient characterizing the RBE of the radiation depends, as its name implies, on the biological and physiological effects of the radiation, and is therefore non-physical. This coefficient is in complex dependence on the type of radiation, its energy, the dose rate, the fractionation of irradiation, the type of biological reaction being studied, the individual peculiarities of the organism and on other factors, many of which are still imperfectly understood. In investigating complex, multi-component radiation, however, a comparison of the different components by reference to their biological effect should rest on a criterion based solely on the physical properties of the radiation, but giving a priori theoretical RBE values which do not conflict with the data of experimental radiobiology and radiation medicine. The local energy losses of particles in tissue may be taken as such a criterion. It has been shown experimentally that the energy locally absorbed per unit length of particle path (LET) is of primary importance in biological injury. With the density of

linear energy loss is associated the concept of radiation quality, the measure of which is the quality factor. The value of the quality factor indicates the biological effectiveness expected for a given radiation. Direct measurement of the quality factor of radiation is one of the most urgent, but at the same time, one of the most difficult problems in radiological protection and dosimetry. (auth)

12876 RADIATION PROTECTION IN DENTAL PRACTICE. Jung, Till (Univ., Bonn). Oeffentl. Gesundheitsdienst., 26: 22-34(Jan. 1964). (In German).

The author illustrates and discusses radiation protection in dental practice in relation to its biophysical foundations, human genetic viewpoints, legal aspects, radiation protection for the patient, and radiation protection for the dentist and technicians. Problems of film sensitivity, filtration, shielding of the radiation beam, and proper positioning of the patient to afford greater gonadal protection from irradiation are discussed. The review provides concise and instructive information for use of radiation in dental work. However, it is necessarily limited in scope, and for details the reader is referred to other sources of information. In daily practice of dentistry a middle ground between over-emphasis and neglect of proper precautions against radiation hazards is necessary. This requires application of many of the possibilities for dose reduction reviewed in this article. (BBB)

12877 BASIC CONCEPTS FOR THE USE OF RADIOACTIVITY IN MEDICINE. A REFRESHER COURSE. 3. DOSE AND EFFICIENCY. Rach, K. (Freie Univ., Berlin). Roentgenpraxis, 18: 161-7(July 1965). (In German).

Units used to measure and evaluate radiation dose are reviewed. These include the ion dose, measured in terms of the R as equal to 2.58×10^{-4} coulomb/kg, and the absorbed dose, measured as the rad, which is equal to 100 erg/g. These two units are related to each other by a factor that varies with the type of material irradiated and the type of radiation involved. The absorbed dose is modified by the relative biological effect of the radiation concerned. Generally, the relative biological effect amounts to 1 for x ray, β, and γ radiation, to 10 for α or proton radiation, and to 20 for heavy nuclei. Calculation of the γ dose factor is illustrated, and its significance in estimation of dose is shown. The concept of half-value thickness layer for several materials is described and discussed. It is illustrated by evaluation of residual activity as a function of half-value thickness. (BBB)

12878 BASIC CONCEPTS IN THE USE OF RADIOACTIVITY IN MEDICINE. A REFRESHER COURSE. 4. TECHNICAL AIDS FOR REGISTERING RADIOISOTOPE RADIATION. Rach, K. (Freie Univ., Berlin). Roentgenpraxis, 18: 185-9(Aug. 1965). (In German).

The concept of half-value thickness for radionuclides and x radiation and detection of radioisotope radiation are discussed. Procedures discussed include blackening of photographic emulsions, ionization of gases, luminescence production in crystals, alteration of conductibility of crystals, color changes in solid state dosimeters, and heat production. Fundamentals of γ spectrometry procedures are outlined. Film dosimetry has the disadvantage of definite inaccuracy, but results are reproducible, permitting evaluation of measurement values to be made. The ionization properties of radiation make the use of ionization chambers, condensor chambers, and counting tubes feasible. Principles of ionization are discussed, and the construction and operation of G-M tubes and scintillation counters are illustrated. (BBB)

12879 STATUS OF RESEARCH ON RADIONUCLIDE REMOVAL SYSTEMS. McCutchen, J. H. (Public Health Service, Washington, D. C.). J. Dairy Sci., 49: 900(July 1966).

A brief progress report is given on a milk decontamination process, a commercial-scale cation exchange system which is a scale-up of the pilot plant model developed at Beltsville jointly by the U. S. Public Health Service, U. S. Department of Agriculture, and the Atomic Energy Commission. The commercial-size equipment is capable of removing 90% of ^{90}Sr from 100,000 lb of milk in 8 hr. This system was developed for emergency use in the event of war or nuclear accidents resulting in release of large amounts of ^{90}Sr to the atmosphere. It is not expected that such equipment will be needed for present or foreseeable levels of ^{90}Sr in this country. The system will be designed to permit it to be loaded on a trailer truck and to allow for its movement from one dairy plant to another. Capacity of the equipment is 12,500 lb/hr. Additional research is planned on the microbiology of ion exchange resins when subjected to cleaning, sanitizing, and storage between milk runs. (BBB)

12880 INFLUENCE OF INHOMOGENEITY IN IRRADIATION OF THE ORAL CAVITY WITH 18 MeV ACCELERATED ELECTRONS. Belletti, S. (Spedali Civili, Brescia). Radiol. Med., 52: 814-23(Aug. 1966). (In Italian).

Using a phantom reproducing the morphology and the tissural composition of the head, the author experimentally determined, by a photographic method, the isodose curves produced by a beam of 18 MeV fast electrons on three different horizontal planes, passing respectively, at the level of the horizontal part of the mandible, at the middle third of the vertical part of the mandible and at the lower alveolar process, and at the upper aveolar process and the roof of the hard palate. These curves show dose discrepancies up to 20% compared with those obtained in homogeneous material (water). It was concluded that the dosimetric estimations based on isodose curves determined in homogeneous tissues or on calculations of the density differences between bony tissue and soft tissue are not sufficiently reliable in irradiation of foci in the oral cavity behind or near to bony formations. (auth)

12881 DISPENSER FOR FREE-FLOWING RADIOACTIVE SUBSTANCES. Barsukov, B. N. Med. Radiol., 11: No. 10, 43(Oct. 1966). (In Russian).

A device was designed for dispensing free-flowing radioactive substances. Radioactive preparations are conveyed from storage to delivery by a worm conveyer. The entire system is encased in lead shielding. A radiometric device is used to apportion preparations. (BBB)

12882 RADIATION EXPOSURE IN CASE OF A REACTOR ACCIDENT. Koenig, L. A. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 12: 497-500; 503(Oct. 1966). (In German).

The radiation exposure of persons in the environment of the site in case of a reactor accident is caused by external irradiation from the safety containment, the airborne effluents released to atmosphere, and by the activity deposited on the ground as well as by incorporation due to the inhalation of contaminated air and the ingestion of contaminated food. The influence of the different types of exposure is estimated. The ingestion of contaminated food is disregarded in this treatment, because it may be controlled in various ways. It is shown that within wide limits of variation of the parameters considered, the thyroid dose by ^{131}I will contribute the main share of the exposure, if the adjacent area is disregarded where the external exposure dominates, because there the airborne activity concentration is zero at ground level. (auth)

12883 PROGRESS IN RADIATION ECOLOGY: RADIONUCLIDE MOVEMENT IN MAJOR ENVIRONMENTS. Olson, J. S. Nucl. Safety, 8: 53-8(Fall 1966).

Several recent meetings and papers extended the information on cycling and levels of radionuclides in terrestrial, freshwater, and marine environments. Prior information in this field was brought together conveniently in the First National Symposium on Radioecology in 1961. One trend in ecological analysis is toward further testing of mathematical models for transfers between parts of a complex ecological system by using equations and analog or digital computer simulations like those which have proved useful in the health physics and physiology of internal dose. Dietary sources of contamination for man are frequently at least as important as sources of contamination from drinking water and air. In assessing hazards, concentration factors based on stable elements could be used more widely than is done at present. Such factors may give rise to conservative estimates of permissible release for elements whose half-life is short or whose transfer through environmental networks is slow. (45 references) (auth)

12884 BETA RADIOACTIVITY OF PLANTS IN VARIOUS REGIONS OF ARMENIA. Ananyan, V. L.; Martirosyan, G. M. (Lab. of Agricultural Chemistry, Academy of Sciences, Armenian SSR). Izv. Akad. Nauk Arm. SSR, Biol. Nauk., 18: No. 1, 63-6(Jan. 1965). (In Russian).

The beta radioactivity of grass and alfalfa growing on typical soils in various regions of Armenia was determined. The radioactivity varied within the rather narrow limits of 1.95 to 3.43×10^{-8}c/kg dry weight over all the regions investigated. An exception was the grass from an alpine meadow at Aragats, which exhibited an activity of 5.64×10^{-8}c/kg dry weight. The percentage of beta activity due to ^{40}K varied from 11.3 at Aragats to 23.7 at the village of Artagyukh (Spitaksk region) and 80.2% at Yerevan. Moss had a higher beta radioactivity than grasses. A sample of moss showed a beta radioactivity in the 0.4 to 2.35×10^{-7} c/kg dry weight range. (JPRS)

12885 PSYCHOLOGICAL EXAMINATION OF OPERATORS OF NUCLEAR REACTORS. Pulcinelli, Mario; Ceci, Giampiero (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Minerva Med., 56: 3941-7(Nov. 14, 1965). (In Italian).

The physical and psychological requirements for operators of nuclear reactors are briefly summarized. It is concluded that the psychological testing of reactor operators is a very important element in the evaluation of their aptitude. (J.S.R.)

12886 RESEARCH WITH GAMMA SPECTROMETRY IN HUMAN AND ANIMAL ORGANS. Lanzola, E.; Petrozzi, E.; Spina, C.

(Univ., Rome). Nuovi Ann. Ig. Microbiol., 15: 395-409(Sept.-Oct. 1964). (In Italian).

Levels of some γ-emitting fallout radionuclides in human and animal tissues were determined in the spring of 1963. γ-Spectrometry was conducted on the lung, trachea, liver, spleen, kidney, testes, and blood of cattle and lung and liver of humans of various ages. Bovine testis, spleen, and kidney showed appreciable amounts of $^{95}Zr + ^{95}Nb$ (250 to 500 pC/kg) and lesser amounts of ^{137}Cs. The presence of ^{103}Ru and ^{106}Rh was detected in blood and testis. Twice as much ^{137}Cs was found in spleen than in liver. Liver of human subjects aged 37 to 74 yr contained ~80 pC/kg ^{137}Cs, and this amount was similar to that found by the whole-body counter in humans. Human lung contained relatively high levels of $^{95}Zr + ^{95}Nb$, up to 1000 pC/kg, and similarly high levels of $^{106}Rh - ^{103}Ru$, up to 1100 pC/kg. The low energy of ^{144}Ce made it difficult to obtain accurate measurements on this radionuclide. (BBB)

12887 A NEW TECHNIQUE FOR FINGER AND HAND DOSIMETRY USING SOLID THERMOLUMINESCENT LiF–TEFLON DOSIMETERS. Bjarngard, Bengt E.; Jones, Douglas (Controls for Radiation, Inc., Cambridge, Mass.). 13p. (CONF-660621–19). ORAU. Gmelin, AED-CONF-66-193-17.

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

Small LiF thermoluminescent detectors incorporated in Teflon fastened to the skin by adhesive tape were found to fulfill practically all the requirements for finger and hand dosimetry and can be worn without interfering with work. The ease and speed of readout is also an advantage. When compared to photographic film detectors, they were found to be capable of the same precision, have vastly superior energy dependence, and lead to better accuracy when worn where meaningful radiation doses were recorded. (C.H.)

12888 MEASUREMENT OF THE RADIOACTIVE ISOTOPE CONCENTRATION IN MILK AND MILK PRODUCTS. Michon, G. (CEN, Saclay, France); Jeanmaire, L.; Madelmont, C. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-75/21, 40p. (In French). (CONF-660711–9). DTIE.

From Seminar on the Use of Radioisotopes and Radiation in Dairy Science and Technology, Vienna.

The most important radioactive contaminants of milk and milk products are reported. The methods used for the detection and measurement of radiations are outlined. The identification of radioisotopes is described. The chemical preparation of the milk and milk product samples is outlined. The principles of the determination of ^{131}I, ^{137}Cs, ^{89}Sr, ^{90}Sr, and Ra are summarized. (J.S.R.)

12889 THORIUM: ITS INDUSTRIAL HYGIENE ASPECTS. Albert, Roy E. New York, Academic Press, 1966. 228p. $7.00.

Thorium is unusual in that the health hazards encountered arise from isotopes of a variety of elements that are present in the decay chain of ^{232}Th. These isotopes encompass a wide range of metabolic, physical, and radiological properties, and the control of thorium hazards involves many types of radiological health protection problems. The major technical uses of thorium are summarized, and other aspects of thorium are discussed, such as hazards common to the various industrial processes, the techniques and objectives for the control of these hazards, and the biological and medical foundations on which these hazard controls are based. Additional topics include physical, chemical, and radioactive properties of thorium and thoron; industrial processing of thorium; thorium and nuclear power; chemical and radiological effects of thorium; metabolism of the principal isotopes in the ^{232}Th decay chain; inhalation hazards; skeletal hazards; hygienic guides; measurement of thorium and thoron hazards; and control of thorium hazards. The book is intended to be of use to persons in the field of health protection, as well as those concerned with the technical aspects of production and research who may wish to gain some insight into the nature of the health problems associated with the use of thorium. (H.L.W.)

12890 ATOMARE GEFAHR UND BEVOELKERUNGSSCHUTZ. (Atomic Hazards and Population Protection). Manstein, Bodo. Stuttgart, J. Fink Verlag, 1963. 68p. 4.80 DM.

The real hazards that could be encountered consequent to atomic warfare are discussed and contrasted with several misconceptions of their effects. These include the preconditions for a modern war, the development of rocket missiles and atomic weapons, the nature of atomic weapons, the complexity of strategic concepts of atomic warfare, defense and protective measures that could be taken against atomic hazards, planning for passive defense, which includes evacuation, shelters, food supply and medical supply, and medical aspects of care of the wounded. The effects of certain aspects of public opinion and legal regulations are discussed, and questions of political impact of population protection are raised and discussed. (BBB)

Medicine

Refer also to abstracts 12851, 12859, 12869, 12870, 12874, 12878, 12956, 12957, 12963, 12976, 12979, 12980, 12987, 12988, 13003, 13004, 13018, 13026, and 13027.

12891 (BNL–9598) RECENT ADVANCES IN RADIATION THERAPY OF INTRACRANIAL MALIGNANCY. Atkins, Harold L. (Brookhaven National Lab., Upton, N. Y.); Chang, Chu H. (Columbia-Presbyterian Medical Center, New York. Dept. of Radiology). [1965]. Contract AT(30-2)-Gen-16. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Recent advances in the radiotherapy of neoplasms are reviewed with emphasis on the treatment of intracranial malignancy. Radiobiological principles that affect the clinical results of radiation therapy are discussed with emphasis on the effect of oxygen on the radiosensitivity of neoplastic tissues and the clinical response to different regimes of dose fractionation. It is pointed out that the oxygen effect is basic in the rationale for use of particulate radiation rather than x or γ and that fractionation effects are related to oxygen enhancement of radiosensitivity and the use of heavy particles for radiotherapy. Recently developed tissue culture methods that have contributed to the understanding of radiobiological principles involved in radiotherapy are discussed. The physical and biological characteristics of x, γ, fast neutron beams, proton beams, deuteron beams, α beams, and heavy particle beams, including pion beams, are reviewed as to applicability for radiotherapy. The use of radioisotopes in the diagnosis and therapy of neoplasms is discussed, with emphasis on the selective localization of labeled antibodies in tumors. The use of radioisotopes, including colloidal ^{198}Au, $Cr^{32}PO_4$, ^{192}Ir, ^{137}Cs, Ra, Rn seeds, ^{198}Au seeds, and sealed sources containing ^{90}Sr and ^{90}Y, alone or together, for the intracavitary treatment of malignancy is also discussed. Clinical experiments using neutron capture therapy, after the administration of boron compounds, for the treatment of brain tumors are reviewed. Preliminary results are reported for a group of patients in whom post-operative treatment of glioblastoma with fractionated hyperbaric oxygen radiotherapy, with a total tumor dose of 3600 rads over a 3 week period with 400 rads used for each treatment, gave encouraging results. (75 references.) (C.H.)

12892 (STI-PUB-122) CLINICAL USES OF WHOLE-BODY COUNTING. Proceedings of a Panel held in Vienna, 28 June–2 July 1965. Panel Proceedings Series. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 302p. (CONF-650673-). IAEA: $6.00; S 126,-; £1.16.0; F Fr 24,-; DM 21,-.

Physical properties of various types of whole-body counters are analyzed with emphasis on the usefulness of different counting geometries for whole-body measurements of radioisotope distributions that vary with time. Presentations of clinical applications of whole-body counting included: electrolyte metabolism with particular reference to muscle disease and obesity; counting of ^{47}Ca and ^{85}Sr in the study of bone diseases; studies of protein metabolism in neoplastic disease; and measurements of absorption and excretion of vitamin B_{12} and iron. (H.G.D.)

12893 (UCRL-Trans-1333) USE OF HIGH-ENERGY PROTONS FOR THERAPY. Voronin, Yu. V. Translated by M. Kassatkin (Lawrence Radiation Lab., Univ. of California, Berkeley), from Med. Radiol., 10: No. 11, 3-9(1965). 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

A summary is presented of literature on problems involved in the therapeutic use of protons, deuterons, and α particles accelerated to an energy of hundreds of MeV. The production of heavy charged particles is discussed briefly and methods used for dosimetry are described. Results from a number of studies on experimental animals showed the following: the sensitivity of tumor cells in vivo is 4 times as great to irradiation by neutrons as to ^{60}Co γ radiation; for radiation with a high density of ionization the biological effect does not depend on the presence or absence of oxygen; and the dose at target depth may be made 150 times as great as the surface dose by the proper combination of multifield and rotational irradiation and focusing of the beam. Animal studies were also used to compare the effects of heavy charged particles on various organs with the effects of x radiation; to determine the long-term after effects of irradiation with heavy particles; and to determine doses required to cause the regression of tumor growth in animals. Therapeutic results of treatment with high energy proton beams are reported on patients with neoplasms of the mammary gland, metastatic mammary gland neoplasms, or diabetes in whom the function of the pituitary was destroyed or depressed by means of proton beam irradiation. Good

results were obtained in the treatment of acromegaly by proton beam pituitary ablation. Results are also summarized on the response to 190 MeV protons of normal and neoplastic tissues of patients with very widely spread neoplasms. It is concluded that beams of heavy particles with their ability to cause well localized tissue destruction are powerful tools for radiobiological studies and radiotherapy. (C.H.)

12894 THE ACRIDINE ORANGE VIABILITY TEST APPLIED TO BONE MARROW CELLS. II. CORRELATION WITH AN IN VIVO IRRADIATED MOUSE ASSAY. Hathaway, W. E.; Newby, L.A.; Githens, J. H. (Univ. of Colorado Medical Center, Denver). Cryobiology, 2: 143-6(Nov.-Dec. 1965)

A comparison was made of trypan blue and eosin dye exclusion tests and the acridine orange (A-O) viability test with an in vivo lethally irradiated mouse assay of viability of marrow preserved by freezing for prolonged periods. When a cell dose of 0.5×10^6 nucleated cells per ml was given, the amount of protection from lethal irradiation decreased as the length of preservation of frozen marrow increased. This decrease in protection, and therefore decreased cell viability, was most consistently reflected by the A-O test. When less than 75% of the cells were viable by the A-O method, decreased protection could be expected. However, if the cell dose was increased, better protection resulted. Marrow preserved for over 9 months gave slightly better protection than fresh marrow. This suggests that the cells responsible for protection against lethal irradiation were more resistant to freezing than the other cells in the marrow specimen. The percentage of bone marrow lymphocytes was increased in the frozen specimens, and the percentage of the other cells was decreased correspondingly when compared to fresh marrow. Consequently, the mice in some experiments received more lymphocytes in the frozen sample than in the fresh aliquot. Although the A-O, eosin, and trypan blue tests compared favorably in estimating the degree of viability of the thawed specimens, only the A-O test is useful in indicating which type of marrow cell is viable, and thus allows a more precise estimate of the effectiveness of frozen marrow to protect against the effects of lethal x-ray treatment. (TCO)

12895 RADIOISOTOPE PLACENTOGRAPHY. Munday, R. N. (Univ. of Adelaide). Med. J. Austral., 1: 18-22(Jan. 1, 1966).

An assessment was made of the radiation dose to mother and fetus in the use of various radioisotopes to localize the placenta, and the doses were compared with those received in radiography. This study in 106 cases includes the use of three isotopes, ^{131}I, ^{132}I, and ^{51}Cr. The greatest drawback to isotope placentography with radioiodine is that fetal thyroid tissue has a marked affinity for it. A comparison of the radiation dose to mother and fetus from the two isotopes of iodine (^{131}I and ^{132}I) with that given during conventional soft-tissue radiography indicated that both maternal and fetal gonads would receive 1000 mrad from two-film placentography, whereas for ^{131}I (5 μC) and ^{132}I (50 μC) the doses would be 15 and 7, and 10 and 5 mRAD, respectively (on the assumption that the fetus remained in utero indefinitely). The dose to the fetal thyroid, however, with ^{132}I would be only 130 mRAD, compared with 4900 mRAD delivered by ^{131}I. These measurements, however, do not consider giving the mother a thyroid-blocking agent beforehand. If a thyroid-blocking agent (such as Lugol's iodine solution) is used, the dose delivered to the fetal thyroid would be well within the values listed by the Federal Radiation Council, and about 1% of the dose delivered by conventional x-rays. However, the use of isotopes of iodine other than ^{131}I (such as ^{132}I and ^{125}I) is desirable, and substitution of radiochromium is another way of overcoming the dangers to the fetal thyroid. Attempts were made to substitute radiochromium attached first to albumin and then to human red blood cells, in place of use of ^{131}I-albumin. The former procedure was not successful, as it was found that nearly 80% of the radiochromium was excreted in the urine in the first 24 hr. Appreciable radioactivity was therefore detectable in the bladder within 15 min of intravenous injection of the isotope, thus making differentiation of bladder from placenta difficult. Chromium-labeled red cells, however, proved satisfactory, provided that all surplus chromium was removed by washing after the labeling of the red cells. Very little of the isotope then appeared in the urine. Results with the test are described. (BBB)

12896 OPTICAL MASERS IN BIOLOGY AND MEDICINE. Malt, Ronald A. (Massachusetts General Hospital, Boston); Townes, Charles H. New Eng. J. Med., 269: 1417-21(Dec. 26, 1963).

Biological effects of lasers are described and their applications to biological research and clinical medicine are reviewed. Microsurgical applications of the optical maser are possible because of the high-power density present for fractions of a second in a spot of minuteness limited only by the resolving power of the light microscope. Moreover, target areas are theoretically capable of being destroyed without appreciable effect on thermal equilibrium in surrounding tissue. Results are described when blood cells are exposed to beams 1.5 to 2.5 μ in dia delivered at 0.5 J in one-half msec from a ruby laser at 6943 Å. Erythrocytes are focally destroyed at will, but white blood cells transmit most of the beam and escape damage except where pigmented areas occur. Thus, by selectively staining certain organelles, discrete intracellular ablation within leukocytes can be done. Various experiments indicate that the effects are similar to those of intense thermal radiation. Practical application of laser photocoagulation has been limited to ophthalmology; the intense beam delivered in a brief pulse has distinct advantages over other sources of light used in "spot welding" a detached retina or in creating focal areas of destruction. However, uses in oncology are developing. (BBB)

12897 ISOLATION OF A LEUKEMIC VIRUS FROM MICE OF THE BALB-c/Cb/Se SUBSTRAIN WITH LEUKEMIA FROM IONIZING RADIATIONS. Ribacchi, Rodolfo; Giraldo, Gaetano; Milia, Ugo (Univ., Perugia, Italy). Lavori Ist. Anat. Istol. Patol. Univ. Studi Perugia, 25: 83-96(1965). (In Italian).

A leukemic virus was isolated in the course of experiments with x-ray-induced BALB/c mouse leukemia. Viral preparations were obtained, following Moloney's method, from mice with primary x-ray leukemia, x-ray transplant leukemia, and from tissue culture fluid of a primary x-ray leukemia culture. Extracts were inoculated into newborn BALB/c mice, less than 24 hr old, subcutaneously or intraperitoneally. Leukemia developed in 2 out of 4 groups of mice inoculated with extracts prepared from primary x-ray leukemia with an incidence of 28.5% and 44.4% at the average ages of 426 and 325 days respectively; in 1 out of 2 groups of mice inoculated with extracts prepared from x-ray transplant leukemia, with an incidence of 50% at the average age of 332 days; and in both groups of mice inoculated with extracts prepared from tissue culture fluid of primary x-ray leukemia culture, with an incidence of 25% and 20% at the average ages of 324 and 321 days, respectively. Of the 10 neoplastic processes histologically examined, 7 (70%) were lymphatic leukemia, 1 (10%) lymphosarcoma, 1 (10%) myeloid leukemia, and 1 (10%) reticulum-cell sarcoma. Two (22.2%) of 9 mice inoculated with an extract from the second passage developed lymphatic leukemia at an average age of 262 days. A discussion is provided on radioleukemogenesis and viral transmission of the disease. (BBB)

12898 ADDITIONAL PROTECTION FROM UNUSED RADIATIONS IN SMALL-FILM FLUOROGRAPHY. Semashko, L. S. Vestn. Rentgenol. Radiol., 40: 47(May-June 1965). (In Russian).

Miniature film radiography is widely used in medical practice so that restriction of the beam to the field examined is important in lowering population exposure to x rays. Factory-made beam-limiting devices do not provide full protection from unused radiation. In addition to the chest field, the neck, arms, and often the small of the back are irradiated, even with a rectangular diaphragm. On account of the scattered radiation the diagnostic value of fluorography may be lowered significantly. To avoid this a special diaphragm was constructed of a 2-mm rolled lead sheet. With this device the focal distance is such that the beam is centered on the screen (dimensions 35×35 cm) of the Fluorograph F-55. The quality of fluorograms is significantly improved with this diaphragm and patient exposure is reduced. (BBB)

12899 NUTRITION AND RADIATION. THE PROTECTIVE EFFECT OF FAT IN RADIATION SICKNESS. Nemec, R.; Eichnerova, V.; Ovecka, M. Cesk. Gastroenterol. Vyz., 18: 402-8(1964). (In Czech).

A study was made of the effect of diets with a different unsaturated fat content on the course of experimentally induced radiation sickness in rats. The best criterion of alteration of the course of radiation sickness was the statistically significant difference in the survival of rats on the 30th and 60th day after 600 R doses of x-irradiation, in the comparison of diets containing lard (16.3% cal volume) and sunflower seed oil (26.3% cal volume). Animals fed lard survived significantly longer than those receiving sunflower seed oil. Similarly, the lard diet gave best results with regard to the blood cell count and the course of radiation sickness during the first days of its development. Least satisfactory was the diet with the high content of sunflower seed oil. It is concluded that a diet that is designed to exert a protective effect in radiation sickness should contain an optimal amount of unsaturated fatty acids, as excessive amounts cause deterioration of the animals' health. This presumably is due to the accumulation of peroxides that are formed from unsaturated fatty acids that accumulate in the body and that exert an adverse effect on metabolism of the animals. (BBB)

12900 RADICAL APPROACH TO HYPOPHYSECTOMY. Edelstyn, George; Gleadhill, Colin; Lyons, Arnold (Northern Ireland Radiotherapy Center, Belfast). Brit. J. Surg., 52: 953-7(Dec. 1965).

Use of ^{90}Y pituitary implantation to treat 102 cases of breast cancer is described, with information on the resulting complications. Surgically, by a right-sided frontal approach, as complete

a removal of the pituitary as possible was achieved. Then, 10 mCi of yttrium-90, previously suspended in wax, was pressed into the fossa. Yttrium-90 is a pure β-particle emitter so the risk of damage to surrounding tissues was kept to a minimum. With this technique the quantity of radiation on the surface of the wax implant was about 100,000-150,000 R and was similar in the center of a 5-mm nodule of gland. The dose to the optic nerves with a satisfactory implant was about 4000 R, while 1 cm deep in the bone it was less than 100 R. The remission rate was better in the yttrium-90 group than in another group treated by surgery alone. Mean survival time was 24 months, 5 months longer than in the surgery-alone series. Yttrium-90 plus surgery seemed to more frequently produce a total hypophysectomy than did surgery alone which resulted in complete withdrawal of the hormones which stimulate the cancer, thereby producing remission. It is suggested that a 30% or greater chance of remission provides justification for hypophysectomy. The disadvantages and hazards of operation assume a much greater importance if the likelihood of benefit is small. The 4% mortality, 2% serious risk to vision (figures based on the last 50 yttrium-90 cases), and the necessity for postoperative maintenance therapy all must be considered. (BBB)

12901 EFFICACY OF RADIOACTIVE IODINE THERAPY FOR HYPERTHYROIDISM. Ahuja, M. M. S.; Malhotra, K. K.; Sridhar, C. B.; Prakash, Atm; Nair, S. K.; Kapur, M. M. (All India Inst. of Medical Sciences, New Delhi). J. Ass. Physicians India, 14: 45-9(Jan. 1966).

Clinical results and side effects of ^{131}I treatment of hyperthyroidism were studied in 190 cases. Patients selected were over 40 yr of age, with the assurance of no future procreation. Youth, pregnancy, presence of thyroid crisis, situation of a goiter in the retrosternal region, or insufficient ^{131}I uptake by a gland were considered as absolute contraindications to ^{131}I therapy. Most patients with an impalpable gland or with mild disease were given 4-5 mCi and post-thyroidectomy patients 5-6 mCi; those with diffuse enlargement and moderately severe disease received a dose of 6-7 mCi. Patients with larger glands, or those with nodular goiters or severe disease were given 10 mCi. Mean dose was 7 mCi per patient. In some severe cases, the effect of therapy was not manifest until 4-6 weeks later. Adequate follow-up was available in only 42 instances. In 8 instances a repeat dose of ^{131}I had to be administered 6-12 months later as the symptoms had not abated and the response was felt to be incomplete. PBI remained high in 6 and the ^{131}I uptake was raised in 5 of the 30 cases where it was possible to study thyroid function. Temporary hypothyroidism manifested mostly as muscle pain, cramp, or stiffness was recorded in 2 instances and permanent hypothyroidism occurred in another 2. Thus only 4% have manifest hypothyroidism, but it is expected that with a more prolonged follow-up their number may increase as a sequel to ^{131}I therapy. Other clinics in India have noted this complication in 6.25% and 10%. The risk of ionizing radiation inducing malignancy, leukemia, genetic changes, or sterility has not yet been substantiated with ^{131}I given in the therapeutic doses for the treatment of thyrotoxicosis. (BBB)

12902 USE OF X-RAY IN OBSTETRICS. Perlin, I. A. Nova Scotia Med. Bull., 45: 15-16(Jan. 1966).

An attempt is made to assess radiation hazards in obstetric radiodiagnosis, and a review is made of the evidence on whether the amount of radiation used in carrying out a pelvic survey in the latter months of pregnancy is hazardous. There is no concrete evidence that somatic effects (that is, physical damage) is a real problem. Early reports that there was an increased incidence of leukemia among children whose mothers had had prenatal abdominal x rays have been refuted. The genetic effect, however, still has to be reckoned with and geneticists feel, basing their statements mainly on the work done in fruit flies and mice, that ionizing radiation will increase the mutation rate in humans. It is the considered opinion of the geneticists that for the welfare of the race any considerable increase in the mutation rate is undesirable and therefore it is important to avoid unnecessary irradiation of the gonads of subjects who have not passed the child-bearing age. Nevertheless the obstetrician's concern must be with the mother and her baby in the immediate future, lest he run the risk of producing obstetrical cripples and damaged babies. The time when obstetrical films are most useful is after 30 weeks gestation, when the danger from exposure, as far as the baby is concerned, should be least. It is concluded that diagnostic radiology can be of great value in handling obstetrical patients and that its use should not be curtailed when information cannot be obtained by other means. (BBB)

12903 PRESERVATION OF BONE MARROW. Ashwood-Smith, M. J. (Medical Research Council, Harwell, Eng.). Bibl. Haematol., 23: Pt. 3, 646-51(1965).

Conditions and techniques for the low-temperature preservation of bone marrow are reviewed, and methods for assessing viability of the cells surveyed. Results with lethally irradiated animals given various doses of marrow usually agree with those obtained from tests in vitro. More exact comparisons of fresh and frozen marrow can be made when graded doses of cells are given and careful histology and peripheral blood counts made, and the best method for assessing viability in vivo is by spleen assay. Recovery of erythropoietic tissue in irradiated animals given frozen bone marrow can also be assessed by measuring the incorporation of radioiron. The presence of cells of donor type and origin can be tested for in the tissues of the irradiated host by chromosome analysis or with immunological tests, giving proof that the frozen graft has taken. Use of various additives, such as glycerol and dimethyl sulfoxide, as protective agents in the freezing of marrow cells is also considered. (TCO)

12904 SCINTILLATION SCANNING IN PEDIATRICS. Kay, Chester; Freeman, Leonard; Avnet, Norman (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Pediatrics, 37: 794-803(May 1966).

An assessment is attempted of radiation exposure risks in radioisotope scanning procedures in children, and use of low doses and optimal radionuclides to reduce such risks is discussed. Although there has been great concern about radiation exposure to children, and despite the fact that the use of radionuclides is widespread, little experimental data derived from metabolic studies are available to calculate the dose received during an isotopic procedure in children. The paucity of data has, in part, been due to the reluctance to administer a radioactive substance to a normal child solely for experimental purposes. There is no good evidence of how much radiation is necessary to produce permanent, significant damage to various organs, if indeed, there are threshold levels. Conversely, no significant damage has yet been noted in children or adults using the dose levels of the isotopes suggested here. A table shows available data on estimates of the whole-body and target organ dose delivered by various radionuclides to pediatric patients. These doses are compared with those received during an intravenous urogram, gastrointestinal series, or barium enema. From these data, it is seen that the whole-body dose from ^{131}I, ^{198}Au, or ^{203}Hg, using the quantity suggested, is less than that from commonly performed gastrointestinal or urological radiographic procedures. The dose to the thyroid is probably negligible from radioiodinated albumin if the gland has been blocked by iodine prior to its administration. It is concluded that organ scanning can be used in pediatrics in the same manner as any procedure entailing a potential risk. It is necessary to weigh the potential risk with the information that can be derived from the procedure. (BBB)

12905 PREOPERATIVE RADIATION FOR CARCINOMA OF RECTUM. Quan, Stuart H. Q. (Memorial Hospital for Cancer and Allied Diseases, New York). N. Y. State J. Med., 66: 2243-7 (Sept. 1, 1966).

It was shown that, in patients with malignant tumors that have broken through the bowel wall and metastasized to the regional lymph nodes, preoperative irradiation resulted in a better 5- and 10-yr survival rate than in patients who had not been irradiated. With a 200-kv x-ray technique, a min of 800 R and a max of 1200 R tissue dose was delivered over a period of from 10 to 12 days. Mild erythema of the skin was produced, and minimal edema of the serosa could be noted. The operative procedure was then undertaken 2 to 3 weeks following completion of pelvic irradiation. No delay or interference with wound healing and no postoperative complications attributable to the irradiation was observed. Irradiation seemed to obstruct the flow of lymph in small vessels and thus perhaps prevents the embolization or further spread of tumor cells. Preoperative irradiation did not seem to affect the mortality rates of patients with tumors which are histologically confined within the bowel wall or whose tumors have broken through the bowel wall but have not metastasized to regional lymph nodes. (BBB)

12906 METHODS FOR THE DESTRUCTION OF THE PITUITARY GLAND. A. RADIOTHERAPEUTIC DESTRUCTION OF THE PITUITARY GLAND. Beringer, A.; Burian, K.; Ellegast, H.; Frey, R. G.; Frischauf, H.; Zeitlhofer, J. (Univ., Vienna). Bibl. Otorhinolaryngol., 12: 47-71(1965). (In German).

As compared to the tissue surrounding it, the hypophysis is relatively radioresistant. The anterior lobe requires from 110 to 190 KR to be destroyed, while the optic chiasma and the oculomotor nerve are destroyed by 60 to 140 and 30 to 60 KR, respectively. Out of 105 patients whose hypophyses were destroyed by ^{198}Au, 5 developed cerebrospinal fluid leakage, but it spontaneously stopped after a week. However, when ^{90}Y was used there were 6 cases observed in 30 patients, which appeared 2 to 4 weeks after implantation. These fistulas required surgical repair and 3 of these patients died. The ones who survived had recurrent fistulas. Even though the surgical risk associated with implantation of ^{198}Au or

^{90}Y is very low, the fistulas produced and their lethality are severe drawbacks. Implantation of ^{90}Y or Rn can also produce blindness because of irradiation damage to the optic chiasma after intervals of 1 week to a yr after implantation. The frequency of optical injuries may range from 10 to over 30%. Other injuries that may result from hypophyseal implantation include tissue necrosis, scarification, empyema, colloid degeneration, and edema. These complications were observed not only in the hypophyseal region but in adjacent areas and tissues, such as the optic nerve, infundibulum, and brain stem. (BBB)

12907 THERAPY OF SUBCUTANEOUS FIBROSIS AFTER TELECOBALT IRRADIATION. Birkner, R.; Hoffmann, B. (Staedtische Krankenhaus Moabit, Berlin). Med. Bild-Dienst, 2: 24-7(June 1962). (In German).

An illustrated account is given of the fibrotic changes in lower layers of skin following ^{60}Co external radiotherapy. Results of successive stages of medical treatment of such fibrosis are demonstrated by color photographs. This late reaction to radiotherapy is increasing in incidence with the use of telecobalt therapy, wherein the relative depth dose is greater than with conventional x-ray therapy. Such subcutaneous induration was treated in 24 ^{60}Co-irradiated patients. This induration appeared within an average of 7 months postirradiation, when the superficial skin changes were waning. It predominated in fat-laden abdominal, lumbar, and paravertebral subcutis, and was noted by a painful and pigmented reaction. It was often accompanied by erythema or dry epitheliolysis as an early reaction, which in 2 to 3 months resulted in thickened, edematous skin. Good results in treating this painful debilitating condition were obtained with analgesics combined with oral doses of vitamins A and E. Local infiltration of the lesions with a hydrocortisone-hyaluronidase-Novacaine preparation was also effective. (BBB)

12908 CONSERVATION OF OVARIAN FUNCTION DURING PELVIC IRRADIATION. Fraser, A. C. (Paddington General Hospital, London). Proc. Roy. Soc. Med., 59: 833(Sept. 1966).

A case is illustrated to indicate how appropriate shielding of the ovaries in young women during pelvic radiotherapy can prevent ovarian hypofunction following irradiation. Most reports dealing with this problem have been in association with the treatment of invasive carcinoma of the cervix, but other conditions may be encountered in the treatment of pelvic malignant disease in young women. In this case, a girl at the age of 14 was found to have Hodgkin's disease. Over the next 5 years she received at intervals deep x-ray therapy for enlarged lymph glands in the neck, mediastinum, and left axilla. At age 19, she developed enlarged lymph nodes in both groins. In an attempt to preserve ovarian function during pelvic irradiation, 2 lead shields were fashioned and placed around both ovaries. Five days after laparotomy a 2-week course of deep x-ray therapy was given. The patient displayed minimal side-effects and the shields were removed at a second laparotomy 3 weeks after the first. Menstruation recommenced 3 weeks later, has been regular ever since, and the patient remains well. (BBB)

12909 LIFE SCIENCE-ORIENTED PROGRAM IN NUCLEAR TECHNOLOGY IN A SCHOOL OF DENTISTRY. Flieder, Donald E. (Univ. of Kentucky, Lexington); Burzynski, Norbert J. J. Dent. Educ., 30: 212-20(June 1966).

A detailed presentation is given of requirements for staff, instrumentation, facilities, and subject matter for a course in nuclear dental medicine. A student teacher ratio of 6-1 is recommended as optimal. It is desirable that each instructor hold an AEC license to handle radioactive materials; however, it is possible to operate such a course satisfactorily using license-exempt quantities of radioisotopes. Each student should be provided with a scaler and G-M detector unit. Additional equipment should include a radiochromatogram scanner and a crystal scintillation counting system for γ-ray counting. Multipurpose ratemeters may also be used. The program presented consists of 4 class sessions, each 4 hr in length. Part of each period is devoted to lecture, part to lab. The lecture subjects and lab experiments present the basic nature of radioisotopes in biologic studies. Other subjects include activation analysis, isotope dilution, autoradiography, atmospheric fallout determination, and counting 2 isotopes (e.g., ^{32}P and ^{35}S) in the same specimen. References of sources of materials available relating to the teaching of courses in radioisotopes are provided. (BBB)

12910 CHEMICAL RADIATION-PROTECTIVE AGENTS. II. Hernadi, Ferenc; Nagy, Zsolt (Gyogyszertani Intezet, Debrecen, Hung.). Orv. Hetilap, 106: 1369-75(July 18, 1965). (In Hungarian).

A survey of chemical radioprotectors is given which includes 45 references. The biological effects of ionizing radiation are discussed in relation to the action of the various chemical radioprotective agents. The conclusions reached are as follows: There are different mechanisms through which the radiosensitivity of each system may be reduced by the use of different chemical agents; various chemical agents of differing structures may show similar protective effects by the same mechanism; at the same time, the same chemical agent may act by a different protective mechanism, depending on the system to which it is applied; it is possible for various mechanisms to act simultaneously in the same system; research on the mechanism of the effect of chemical radioprotectors is linked closely with research on the analysis of radiation sensitivity of the target substance (e.g. DNA). It is concluded that it is possible to specify only the most probable mechanism of action for a certain chemical compound for a specific system; this does not preclude, however, that the same compound in a different system would act through a different mechanism. (BBB)

12911 DISORDERS AMONG IN UTERO EXPOSED CHILDREN. Tabuchi, Akira; Hirai, Tsuyoshi; Sanada, Mitsuaki; Nakagawa, Shigeru; Sata, Hideo (Hiroshima Univ.). Hiroshima J. Med. Sci., 14: 209-22(Dec. 1965).

A survey is made of various reports relating to death rate and abnormalities in children born to women who were pregnant at the time of exposure to the atomic bombing of Hiroshima. This survey draws 2 major conclusions: The death rate of in utero exposed children after birth was greater than that of controls for about 7 yr following exposure, but there was no difference subsequently. It was estimated that there are still living a large number of in utero exposed cases with developmental impairment, microcephaly, and mental retardation. Exposure distance of the mother affected the death rate of girls, that is, the death rate decreased as the distance from the hypocenter increased. The death rate of exposed children was higher for boys than for girls throughout the periods of infancy, childhood, and primary school age, and particularly the difference during the childhood period was significant, whereas among the controls the death rate for girls was high only during the infancy period. The death rate for exposed children was higher than the controls, particularly during the primary school age period. Generally the death rate by cause of death was higher among the exposed than the controls. Deaths due to neoplasms and circulatory diseases were particularly high among exposed boys while infectious diseases (including tuberculosis), parasitic diseases, circulatory diseases, and neoplasms were the major causes among exposed girls. Boys exposed during the first trimester of gestation had smaller pelvic breadths and some were brachycephalic, while boys exposed during the terminal trimester of gestation had smaller shoulder breadths. Boys exposed in utero at distances under 2000 m generally had smaller pelvic and shoulder breadths. The incidence of microcephaly was increased among the in utero exposed as compared to the nonexposed and those exposed during infancy. There were 38 cases of microcephaly among the in utero exposed. Those exposed during the early stage of gestation and those exposed at a proximal distance from the bomb showed an increase in incidence of microcephaly. (BBB)

12912 ON THE SIGNIFICANCE OF CAUSE OF DEATH AS RECORDED ON DEATH CERTIFICATES IN HIROSHIMA AND NAGASAKI, JAPAN. Jablon, S.; Angevine, D. M.; Matsumoto, Y. S.; Ishida, M. (Atomic Bomb Casualty Commission, Hiroshima). Nat. Cancer Inst. Monogr., No. 19, 445-65(Jan. 1966). (TID-21370).

Data from death certificates and autopsy reports collected over a 12-yr period for 1215 Japanese survivors of atomic bombings are presented. Reports up to September, 1962, are considered in relation to sex, city, distance from hypocenter, age, place and cause of death. Bias in relation to these factors was assessed. Relation between underlying cause of death as shown on the death certificate and autopsy diagnosis is calculated. Agreement is good with respect to deaths from malignant neoplasms, and with respect to the major cardiovascular-renal diseases considered as a class. Leukemia was well diagnosed on the certificates, as were malignant neoplasms of the digestive organs, breast, and uterus. Because of difficulties inherent in the application of an unsuitable system of rubrics to deaths from cardiovascular disease, it was not possible to obtain definite results with respect to cerebrovascular disease or coronary artery disease, but indirect evidence is adduced which implies that the certified causes are probably reasonably reliable at least with regard to the relative importance of these 2 classes of cardiovascular disease. Most forms of malignant disease, even primary malignancy of the stomach, are underdiagnosed on death certificates and the true mortality rates from these diseases, with particular exceptions, are probably underestimated by vital statistics death rates. Diagnosis of tuberculosis on death certificates became increasingly unreliable, probably because of the decreasing number of such deaths coupled with a shift toward the older ages. However, accuracy of diagnosis with respect to malignancy increased. (BBB)

12913 DIRECT BLOOD TRANSFUSION IN THE TREATMENT OF ACUTE RADIATION SICKNESS. Berkytov, A. N.; Korobkina,

A. G.; Bochagova, D. I.; Zimina, E. P. Voenno-Med. Zh., 2: 26-8(Feb. 1965). (In Russian).

Experiments were conducted with 10 dogs by performing blood transfusions after ionizing irradiation at doses of 500 R. Two hr after irradiation, blood transfusion was begun and continued daily for 4 or 5 days. Dogs which had been irradiated but did not undergo transfusions served as controls. Body temperature of nontransfused, control dogs reached 40 to 41°C, while transfused-irradiated dogs had no temperature rise. The duration of the febrile period was 8 to 10 days. Disorders of the gastrointestinal tract and hemorrhagic diatheses were absent in treated dogs, and no loss of weight was noted. The leucocyte count in treated dogs fell to 2000 to 2400 cells per mm^3, but in control dogs fell to 300 to 500. The erythrocyte count and hemoglobin level were also higher in treated dogs than in controls, while bone marrow cell counts dropped to $30,000-50,000/mm^3$ in treated dogs and to 1000–1500 in control dogs. Two of the 10 treated dogs died before the experiments were completed. The most favorable effects of blood transfusion are obtained if they are begun on the day the radiation syndrome is noted and continued during its height. (BBB)

12914 THERAPEUTIC MODIFICATION OF ACUTE RADIATION ILLNESS IN DOGS BY SPLENECTOMY. Ladner, H. A.; Gruenagel, H. H.; Koslowski, L.; Schweikert, C. H. (Univ., Freiburg i. B.). Arch. Klin. Chir., 313: 749-52(Dec. 20, 1965). (In German).

Dogs were given 400 R of whole-body x irradiation 24 hr after splenectomy. Survival rates were similar whether the irradiations were administered 1 or 24 hr after splenectomy. The leukocyte decrease observed in these animals was less than in animals that were irradiated without splenectomy. Animals that were irradiated but not splenectomized died from infections and hemorrhages ~21 days after irradiation. The ratios of serum proteins decreased in irradiated, nonsplenectomized animals. The albumin-globulin ratios decreased and the α_1- and α_2-globulin values increased ~21 days after the initial postirradiation decrease. Immunological changes could be detected electrophoretically. These paralleled the survival experience of the animals, regardless of whether they were splenectomized in addition to being irradiated or were irradiated only. (BBB)

12915 THE CONTROL OF RADIATION SICKNESS WITH THIETHYLPERAZINE (TORECAN). Johnson, E. M. (Auckland Hospital, New Zealand). New Zeal. Med. J., 64: 649-50(Nov. 1965).

Patients undergoing deep x-ray treatment for malignancies are frequently troubled by vomiting and nausea. Radiation sickness occurs most frequently in patients receiving radiation treatment to the abdomen and lumbar regions, to a lesser degree in the treatment of breast and thorax, and to a limited extent in the treatment of the head and neck. Thiethylperazine, a new member of the phenothiazine group, was tested for antiemetic action with minimal tranquilizing or sedative properties. Thiethylperazine maleate differs from the other drugs of the perazine series because it is a specific antiemetic without tranquilizing properties and without significant extrapyramidal effects. Its mode of action is discussed. (TSS)

12916 A COMPARISON OF CHLORMERODRIN-^{203}Hg SCINTIENCEPHALOSCANNING WITH NEURORADIOLOGY AND ELECTROENCEPHALOGRAPHY FOR THE LOCALIZATION OF INTRACRANIAL LESIONS. Afifi, Adel K.; Morrison, Robert R.; Sahs, Adolph L.; Evans, Titus C. (State Univ. of Iowa, Iowa City). Neurology, 15: 56-63(Jan. 1965).

Radiation doses received by the patient and comparative benefits of several radioisotope and radiologic procedures were compared. In 450 patients a comparison was made of the localizing accuracy of chlormerodrin-^{203}Hg scintiencephalo-scanning with neuroradiology and electroencephalography in a variety of intracranial lesions. There were 49 histologically proved primary neoplasms and 13 metastatic neoplasms, 84% of which were correctly localized by scintiscanning, compared with 91% by angiography, 85% by pneumoencephalography, 100% by ventriculography, 17% by skull films, and 60% by electroencephalography. (TCO)

12917 EFFECT OF LASER ON CARCINOMA IN MAN. Rosomoff, Hubert L. (Albert Einstein Coll. of Medicine, Bronx, N. Y.); Hellstrom, Richard; Brown, Jerry; Carroll, Fred. J. Amer. Med. Ass., 192: 167-8(Apr. 12, 1965).

Effects of ruby laser radiation on carcinomas in 2 humans are described. The laser used emitted light at a wavelength of 6942 Å with the delivery of 1 to 3 J of energy in a pulse duration of 0.0005 sec. This is a rated power output of 2000 to 6000 W. When focused to an area of less than 1 mm^2, the power flux delivered was in the order of 200,000 to 600,000 W/cm^2. In case 1, a squamous-cell carcinoma of the larynx was exposed to a $\frac{1}{4} \times 3\frac{1}{4}$-in. ruby laser under 800-J excitation. The beam was focused through a 4-cm dia quartz lens, with a focal length of 9 cm. Five bursts delivered to a target depth of 5 to 8 cm through the center of the lesion resulted in partial necrosis of the tumor over a 6-week period. A second exposure was done after the posterior quadrant was painted with Evans blue dye to enhance potential absorption of energy in that sector; the lower half was not exposed. No surface reaction was detected on the tumor after irradiation. Microscopic examination of hematoxylin-eosin-stained slides disclosed nuclei which were irregular, large, and hyperchromatic. Dense, collagenous stroma was present. Foci of necrosis were found throughout the tumor. Within these, a pattern of rounded areas of necrosis could be discerned at points of laser impact. There were also present, larger areas representing spontaneous necrosis of tumor. Histologically, there were no characteristics to distinguish one form of necrosis from the other. In Case 2, irradiation of a lung tumor metastasis resulted in no special characteristics in the area of necrosis, and no surrounding inflammation was seen. The mechanism by which laser produces necrosis is, as yet, unknown. Although the heat generated at the point of impact is intense, burn is not the likely explanation, as none of either the gross or microscopic characteristics of burn pathology are to be seen. (BBB)

12918 LASER TREATMENT OF EXPERIMENTAL MALIGNANT TUMORS. McGuff, Paul E.; Deterling, Ralph A. Jr.; Gottlieb, Leonard S.; Fahimi, H. Dariush; Bushnell, David; Roeber, Fred (Tufts-New England Medical Center, Boston). Can. Med. Ass. J., 91: 1089-95(Nov. 21, 1964).

Effects of ruby laser radiation with energies up to 12,000 J/cm^2 on 22 types of tumors growing in hamsters were studied. Treatment of some human tumors is also described and some recommendations for safety precautions in the laser lab are presented. All malignant melanomas and thyroidal carcinomas of human origin, implanted in hamsters, in which laser treatment was completed, showed no evidence of tumor grossly or histologically up to the last date of observation. For effective laser therapy, tumors must be exposed for direct treatment and no distant spread should be present. Temperatures within tumors were recorded using micro-miniature thermocouples inserted at depths of 2, 5, and 10 mm below the laser impact area. Max temperatures at the three thermocouple depths were: 716, 201, and 115°F. Thermal decay time of a tumor treated with a laser energy burst was 6 to 12 times longer than the thermal decay time of a tumor treated with a red-hot cautery. To minimize hazards to personnel, laser laboratories should have a high level of general illumination which will keep the pupils constricted. If a laser misfires, this limits to an extent the energy which might inadvertently enter the eyes. Personnel working with lasers should have retinal, visual-field, and slit-lamp examinations at bi-monthly intervals to determine individual retinal damage, if any, and the efficacy of the eye protection of all personnel. Protective goggles designed to filter out specific wavelengths of a particular laser system afford some protection, but this may be only partial and these goggles should not be entirely depended upon. (BBB)

12919 SIGNIFICANCE OF CERULOPLASMIN IN CERVICAL CARCINOMAS IN VARIOUS STAGES. Graf, H. (Univ., Tuebigen, Ger.). Med. Welt, 35: 1059-64(May 8, 1965). (In German).

Ceruloplasmin concentrations in plasma were studied in patients immediately before and at 1, 3, 7, 14, 21, 28, and 35 days following 3 intrauterine treatments of 1200 mg-hr of Ra each and 3 intravaginal treatments with 960 mg-hr of Ra. In addition, all of the patients received pendulum convergence irradition amounting to 3200 to 3400 R focal dose per parametrium. The average value of ceruloplasmin in patients with Stage I carcinoma increased continuously during irradiation and throughout the study, reaching a value of 35.2 mg% on day 35 when the study was concluded. With Stage III carcinomas the initial value was high and tended to decrease continuously. However, the changes were not statistically significant. The increases observed paralleled the necrobiotic changes that occurred. Since these were only slight in early cases, the ceruloplasmin values were not greatly increased, and for this reason this factor is not suitable for early detection of carcinoma. Estimation of ceruloplasmin did have prognostic value. Increased concentration during treatment followed by a slow decrease indicated tumor regression. A rapid drop during treatment indicated a poor prognosis. An increase following a drop suggested recurrence or inflammatory changes. References cited, 51. (BBB)

12920 NEW TECHNICAL AIDS FOR PEDIATRIC X-RAY DIAGNOSIS. Buehlmeyer, K.; Schuster, W.; Gajewski, H. (Univ. Munich). Roentgenpraxis, 18: 193-201(Sept. 1965). (In German).

The use of automatic exposures in lung studies of children of all age groups, enlarged single and serial photos of x-ray image amplifier pictures with a 70-mm camera, and the use of x-radia-

tion cinematography at a high image frequency for angiocardiographic studies have helped to reduce the irradiation dose to patients. As shown by measurements made in a phantom, at a frequency of 200 frames/sec the patient will receive a dose that is just about equal to the dose received from 10 normal x-ray photos made with amplifier foils. Thus the dose is about the same order of magnitude as from serial photos made by a film changer at 6 to 12 frames/sec. In the thoracic region this would correspond to a skin dose of 1 to 2 R. The most important advantage of high-frequency x-ray cinematography is the improved chronological analysis of the events observed, which is possible because of the apparent prolongation of events observed when the film is projected. The two most important advantages of 70-mm photos are the small irradiation dose required to produce a properly blackened film and the decreased film costs. The radiation necessary for a 70-mm film is only ~10% of the dose required for a normal x-ray photo with amplifier foils. Blurring due to movement is reduced too, because the exposure time is much briefer. (BBB)

12921 EXPLORATION BY RADIOACTIVE IODINE OF HYPERTHYROIDISM APPARENTLY CURED BY ISOTOPIC TREATMENT. Swyngedauw, J.; May, J. P.; Linquette, M. (Centre Oscar Lambret, Lille). Lille Med., 9: 906-9(Dec. 1964). (In French).

The effect of therapeutic doses of radioiodine on thyroid gland function in hyperthyroidism was studied with diagnostic doses of radioiodine in 284 cases. In 45% of the cases the shape of the ^{131}I uptake curve (percentage of administered dose incorporated vs time) was normal, in 11.5% it was of the hyperthyroid type with greater than normal uptake, in 33% it was also of the hyperthyroid type but with normal uptake, and in 10.5% of the cases a hypothyroid-type curve was seen. The rapidity of ^{131}I uptake exceeded the normal limits in 43% of cases, and total uptake was above normal in 31% of the cases. In 19.5% of the patients the peripheral levels of ^{131}I six hr after its injection were lower than the normal value of 10%; in 80.5% they were higher than 10%. The low values were associated with normal-type uptake curves. In 70% of cases the protein-bound ^{131}I level was greater than 0.5%. Various possible reasons for the residual anomalies in thyroid function are discussed. Thyroid irradiation causing cellular injury modifies the intrathyroid metabolism of iodine. These anomalies may merely be artefacts secondary to modifications of the extra- and intrathyroid iodide pools which alter the distribution of the radioiodine. It is emphasized that such anomalies should never provide the reason for giving additional therapeutic doses of radioiodine. (BBB)

12922 HALF-FACE PLANING OF PRECANCEROUS SKIN AFTER FIVE YEARS: AN EVALUATION. Burks, James W. (Tulane Univ., New Orleans); Marascalco, John; Clarke, Wallace H., Jr. Arch. Dermatol., 88: 572-85(Nov. 1963).

A method for removing premalignant skin resulting from chronic radiodermititis is presented. A clinical and histologic evaluation of the effects of wire-brush planing of senile and radiation-damaged skin based upon 5-yr observation of 15 half-face planings indicated that planing prevented development of precancerous and cancerous lesions of the skin. The degree of improvement of planed over unplaned sides of the face was 85% cosmetically and 92% therapeutically. Histologic observations indicated profound changes in planed skin that probably accounted for favorable clinical effects. Wire brush planing produced a fibrogenic zone ultimately resulting in deposition of a wide band of new fibrous tissue and either replaced damaged tissue or placed a broad band of new tissue between the area showing radiation degeneration and the epidermis. New elastic fibrils were demonstrated in this fibrogenic zone. Some were found vertical to the epidermis and some extended to and seemed to fuse with the basement membrane. It is concluded that planing has definite but limited value in the prophylaxis of precancerous lesions and is most effective when used before the appearance of extensive and advanced keratotic changes. (TSS)

12923 USE OF LIQUID-SCINTILLATION SYSTEMS IN BIOLOGICAL STUDIES. Ehlers, M. H. (Washington State Univ., Pullman). J. Dairy Sci., 49: 1023-4(Aug. 1966).

Advantages, preparation, and biological uses of liquid-scintillation counting systems are briefly reviewed. The widest application of liquid scintillation counting is with low-energy (soft) β emitters, at least 15 being adaptable to such counting. Two features of liquid scintillation systems contribute to their relatively high counting efficiency of low-energy β emissions. These features include the satisfactory geometry and the elimination of absorption problems, since the medium contains the isotope and the fluorescing materials. A third feature is response proportional to the energy of the emission which, together with certain other instrument features, permits counting within windows. Proportional counting makes it possible to eliminate much background that aids in counting isotopes having relatively low activity. Instrumentation advances permit double-label counting such as with ^{3}H and ^{14}C. The utility of biological studies continues to increase, because of the development of systems which permit the counting of water-soluble materials. (BBB)

12924 TELEVISION FLUOROSCOPY IN GYNECOLOGIC DIAGNOSIS. Rozin, Samuel; Schwartz, Armin (Hadassah Univ. Hospital, Jerusalem). Obstet. Gynecol., 26: 524-30(Oct. 1965).

Dose reduction to the ovaries in the course of television fluoroscopy, as compared with conventional methods, is described on the basis of experience with television fluoroscopy during uterosalpingography in 700 cases. Television fluoroscopy provides sharp and brilliant images of normal or slightly enlarged dimensions with adjustable variation of contrast. The examination is carried out in a dimly lighted room without the need of total darkness. The radiation dose to the ovaries is so small that continuous and prolonged fluoroscopy becomes permissible. The radiation dose during 1 min of continuous fluoroscopy is equivalent to that during the exposure of one x-ray film. Television fluoroscopy reduces the number of roentgenograms in uterosalpingography because it obviates the need for a scout film; for documentation, only one or two films need be taken when the uterus and tubes are seen to best advantage on the television screen. The duration of the whole procedure of uterosalpingography is greatly shortened by the use of television screening, and the examination may be completed within a few minutes. Television screening should be used whenever uterosalpingography is performed. It is indispensable in the study of uterine and tubal physiology under normal conditions, and is of value in the evaluation of functional and anatomic abnormalities in cases of sterility, recurrent abortion, and abnormal uterine bleeding. The use of television fluoroscopy during uterosalpingography should be an integral part of a teaching program in gynecology. The progress of the examination can be observed by several persons simultaneously without the need for dark adaptation. (BBB)

12925 PHOTOSCINTILLOGRAPHY: A DIAGNOSTIC UTILIZATION OF RADIOISOTOPES IN CLINICS. Ephraim, K. H. Verhandel. Koninkl. Vlaam. Acad. Geneesk. Belg., 27: 373-487 (1965). (In Dutch).

Photoscintillation scanning is a technique to show on photographic plates the distribution of radioactivity in the body of a patient. The principal problems are getting the maxiumum information from the lowest dose, collimation, registration, and analysis and interpretation. Each of these problems and the most promising solutions are discussed in some detail. The diagnostic results obtained in the photoscintillation scanning of 4 organs of the body (thyroid, liver, spleen, and kidney) are reported and discussed. (J.S.R.)

12926 SEROLOGIC RESPONSE OF ATOMIC BOMB SURVIVORS FOLLOWING ASIAN INFLUENZA VACCINATION. Kanamitsu, Masatsugu (Sapporo Medical Coll.); Morita, Katsuhiko; Finch, Stuart C.; Kato, Hiroo; Onishi, Shigeyuki. Jap. J. Med. Sci. Biol., 19: 73-84(Apr. 1966).

Antibody response was studied in 151 persons living in 1961 who had been exposed to the atomic bomb in either Hiroshima or Nagasaki, while in utero, within 2000 m of the hypocenter. The control group was of a similar age and sex distribution but located beyond 3000 m at the time of the bombing. These latter subjects received negligible amounts of ionizing radiation. All subjects were inoculated with an Asian influenza virus vaccine. The relation between the distance from the hypocenter at the time of the bombing and production of complement-fixing antibody to various types of influenza A virus was observed. The patterns of the antibody levels in the group beyond 3000 m suggested that the virus of primary infection in the survivors was type A1. Significantly reduced A1 type serum antibody levels were noted in both pre- and postvaccination sera of the subjects within 2000 m of the hypocenter in Nagasaki. The effect of previous radiation exposure appeared much more clearly in the heterotypic antibody response following Asian influenza vaccination; that is, the antibody responses to type A1 viruses were almost completely suppressed in the subjects exposed within 1600 m in both cities despite the fact that the antibody responses to type A viruses were similar to those in the group beyond 3000 m. In contrast, homotypic antibody response to Asian type virus was augmented in the subjects proximally exposed. (BBB)

12927 ATOMIC ENERGY: ITS PRESENT DAY STATUS IN MEDICINE. Dunham, Charles L. (Atomic Energy Commission, Washington, D. C.). Rhode Island Med. J., 48: 359-62; 377(July 1965).

Recent developments in the use of radioisotopes in metabolic studies, clinical scanning, and activation analysis are reviewed.

The variety of isotopes now available for experimental and clinical uses is referred to, and the possibility of developing labeled materials for clinical scanning by a systematic program is mentioned. Development of the use of ^{99m}Tc for scanning is traced. (TSS)

12928 NEW CONCEPTS IN DENTAL X-RAY MACHINES. Richards, A. G. (Univ. of Michigan, Ann Arbor). J. Amer. Dent. Ass., 73: 69-76(July 1966).

A new type x-ray head was designed and tested that permits the source-skin distance (SSD) to be increased without increasing the external length of the directing cone. The x-ray tube of the new head is located behind the transformers and near the back of the x-ray head. Such an arrangement provides a 14-in. SSD, half of which lies within the tube housing. The unit produces better radiographs with less exposure of the patient and operator to scattered radiation than is possible with conventional dental x-ray machines operated with short, pointed cones. In the new machine, a small filter is located close to the x-ray tube, and the small amount of scattered radiation it produces is carefully collimated to go in substantially the same direction as the usable primary beam. This permits the external portion of the directing cone to be made of transparent plastic for better visibility. Because of the recessed location of the filter, the careful collimation of the usable primary beam, and the use of an open-ended cone, the new machine will produce less gonadal exposure of the operator than that produced with current dental x-ray machines. (BBB)

12929 WORLD-WIDE SPREAD OF HIGH-ENERGY TELETHERAPY FOR THE CURE OF TUMORS. Tomiselli, M. Radiaz. Alta Energia, 4: 71-4(Jan. 1965). (In Italian).

A survey is made of the world-wide distribution of high-energy radiotherapy sources, including those employing ^{60}Co, ^{137}Cs, and ^{192}Ir, betatrons, linear accelerators, Van de Graaff generators, and synchrotrons. Advantages of high-energy radiations produced by such sources are cited, including their sparing of tissue between the skin and deep tumors. The survey shows a total of 1751 such sources in operation in 1963 as contrasted with 1451 in 1961, ~200 in 1958, ~20 in 1955, and only 2 in 1951. In 1963, most of these devices were in use in North America (647), mainly in the United States (565), with similar number installed in Europe (675), and fewer in Asia (325), South America (77), Africa (13), and Oceania (14). By far the greatest proportion consists of ^{60}Co sources, 1463 out of the 1751 total, with the remainder consisting of ^{137}Cs, 96; betatrons, 80; linear accelerators, 43; and Van de Graaff generators, 33. The energies of various units operating in various countries are outlined. (BBB)

12930 THE PHLOGISTIC FACTOR AS AN OBSTACLE TO ONCOLOGIC RADIOTHERAPY. (UTILITY OF THE USE OF PYRROLIDINOMETHYLTETRACYCLINE). Nuvolone, U. (Istituto di Radiologia, Novara, Italy). Gazz. Int. Med. Chir., 67: 1903-9(Sept. 15, 1962). (In Italian).

The use of this antibiotic to reduce inflammatory complications of radiotherapy in 45 patients was explored. Inflammatory lesions of the bladder and lung particularly may accompany radiation treatment of cancer in these sites, as a result of lowered resistance of devitalized tissues to endogenous flora. The usual defense systems, such as serum bactericidal activity, properdin and opsonin levels, and phagocytic and antibody-producing cells, may be impaired by both the malignancy and radiotherapy. In the clinical trial described, the antibiotic was injected intravenously in daily doses of 275 mg for two to 9 days. These doses were well tolerated both locally and systematically. Most of the patients were being irradiated for lung, bladder, or uterine cancer. Results were considered excellent in 17 cases and satisfactory in 22. (BBB)

12931 LASER RADIATION IN THE SYRIAN HAMSTER. Fine, S. (Northeastern Univ., Boston); Klein, E.; Scott, R.; Seed, R. Skin, 2: 43-8(Feb. 1965).

The effects of a laser beam of ~30 J at a wave length of 10,600 Å, on the skin of the hamster, were examined. This intensity used was sufficient to produce a perforation of 1.2 mm dia when directed against a steel plate 0.25 mm in thickness. The immediate effects in skin were similar to those of a thermal burn extending over a roughly circular area, 3 to 8 mm in dia with a mild erythematous areola 1-2 mm in width. When a cheek pouch was exteriorized and exposed to laser irradiation, the immediate reaction was similar to that of a moderately severe burn. In a tumor-bearing cheek pouch, the lesion on the surface was accompanied by deep hemorrhage. The gross appearances of the lesion in normal skin on the 5th day following irradiation indicated a more severe reaction in the lighter colored areas than in more deeply pigmented regions. This corresponded with the results of microscopic studies. These showed coagulation necrosis, leukocytic infiltration separating necrotic areas from viable tissue, and epithelization originating from the margin of the lesions. In the areas exposed to laser radiation, the pigment was altered or absent. Pigment, such as melanin, and some dyes are relatively opaque to the incident radiation, and therefore absorb more of the energy of the radiation than less opaque material, such as adipose tissue or the fibrillar components of the connective tissue in the dermis. The effects of laser radiation, therefore, may be more marked on the more opaque materials and, depending on the material, more or less marked on adjacent tissue. (BBB)

12932 ON THE ROLE OF NUCLEIC ACIDS IN THE BIOLOGICAL ACTION OF IONIZING RADIATION AND IN CARCINOGENESIS. Harbers, Eberhard (Univ., Goettingen, Ger.). Radiologe, 6: 75-85(Mar. 1966). (In German).

Injury to the cell from ionizing radiation comes about through the combination of many single effects. Among these the effects on the genetic apparatus is critical. Studies of these effects on structure and function of the genetic material have answered some questions, but raised many others. They do not indicate specific quantitative contributions of these changes to the total radiation injury. The exact mode of action of radiation on the nucleic acids or nucleohistones is still unknown. Two cases described by the author indicate a relation between somatic mutation and carcinogenesis. In view of the conflict previously assumed between the mutation hypothesis and the virus theory of carcinogenesis, these cases raise a problem since viruses appeared to be involved in both cases. Disturbances in the genetic control mechanisms other than by somatic mutations may give rise to cancers. These two types of carcinogenesis can be compared in some cases of experimental cancer production. However, the reasons are still unknown why spontaneous tumors that are observed in human pathology are induced. The hypotheses that have been advanced for the problem of biological aging suggest that the formation of human neoplasms may reflect functional disturbances in the regulation of genetic activities. References cited, 118. (BBB)

12933 RESULTS AT THE HEIDELBERG CLINIC WITH TRANSCUTANEOUS PITUITARY DESTRUCTION ACCORDING TO K. H. BAUER. Linder, F. Bull. Soc. Int. Chir., 23: 227-9 (Mar./Apr. 1964). (In German)

Because of a very abrupt decrease in dose from ^{90}Y, this radioisotope requires a multilocular implantation. This fact, as well as the fact that most laboratories use a transnasal introduction of the ^{90}Y needle, is probably responsible for the very large number of meningitides and spinal canal fistulas observed in ^{90}Y use. The abruptly decreasing β irradiation emitted from ^{90}Y implants causes a greater histologically necrotized tissue volume than does the γ irradiation emitted from implanted ^{198}Au. However, the subnecrotic dose has a clinically detectable effect on decreasing hypophyseal function. The most frequently appearing complication of ^{90}Y implantation is formation of spinal fluid fistulas. In a survey of 470 patients such fistulas appeared in 19 (4%). Visual disturbances appeared in 8 (1.7%) and diabetes insipidus was detected in 16 (3.4%) of the patients. Only one of the patients with a fistula died as a result of it, 5 were closed surgically, and 4 developed meningitis. On the basis of these relatively favorable results, implantation of ^{90}Y is probably a favorable procedure as compared to ^{198}Au implantation. (BBB)

12934 EFFECT OF RADIOISOTOPE THERAPY ON THE INTENSITY OF THE TUBERCULIN REACTION. Pongor, Katalin; Petranyi, Gy. (Medical Univ., Debrecen, Hung.). Acta Med., Acad. Sci. Hung., 22: 71-4(1966). (In German).

The tuberculin reactivity of patients free of active tuberculosis who had been treated with between 4.5 and 10 mCi of ^{131}I for hyperthyroidism, or with 4 to 5 mCi of ^{32}P for polycythemia, was tested. Their ages ranged from 35 to 60 yr, and the sex distribution was equal. Among 18 of the patients tuberculin positivity had an infectious origin. The tuberculin test was given 5 to 6 days prior to ^{131}I and ^{32}P administration, and was repeated 24 or 48 hr afterwards, a few cm from the first test. In all, 21 treated patients, of whom 11 were hyperthyroid and 10 were polycythemic were studied. Of these patients 12 received the tuberculin 24 hr after conclusion of the radioisotope treatment, and 9 received it 48 hr afterwards. The control group consisted of 52 hyperthyroid or polycythemic patients who had not received radioisotope treatments. For comparative purposes, tuberculin-negative guinea pigs that received ^{131}I, ^{32}P, or ^{35}S before or after additional tuberculin tests were studied and compared with animals that received no radioisotopes. The results of the tests in patients showed generally no sensitization and the first test did not increase sensitivity. In cases where the subsequent test was performed on adjacent areas of skin there was a small nonspecific acceleration of reaction that decreased within a few min. If the second test was performed at a different location, this minor reaction did not

appear at all. The intensity of the reaction was not enhanced by use of radioisotopes. (BBB)

12935 RADIOLOGY: A NEW STRATEGY FOR SEARCHING THE SHADOWS. Tuddenham, William J. (Pennsylvania Hospital, Philadelphia). J. Amer. Med. Ass., 196: Suppl., 36(June 20, 1966).

Progress in developing a new program for more accurate examination and diagnosis of x-ray films is reported. The technique presently is programmed for search and diagnosis of gall bladder and colon films and involves a yes or no question at each step in analyzing the x-ray film. Each answer determines which of a following group of questions must be answered in the step-by-step process. This programmed sequence was used to teach third-year students and others, and is now being evaluated. A flow chart is illustrated. Theoretically, at least, the method is applicable to all x-ray diagnoses of any part of the body. It probably will be applied next to the genitourinary and chest areas. Programming will be more difficult in an area such as the chest, where visual discrimination is more complex and diagnostic possibilities more extensive. (BBB)

12936 MEASUREMENT OF THE DEGREE OF THE BUILD-UP EFFECT IN ^{60}Co AND ROENTGEN RADIATION OF 17 MeV. Drexler, Guenter; Wachsmann, Felix (Gesellschaft fuer Strahlenforschung mbH, Munich). Strahlentherapie, 132: 1-7(Jan. 1967). (In German).

The dependency of the build up effect on field size, source-skin distance, and on the radiation energy is discussed. Furthermore, the existence of a so-called "build down" effect and its value for ^{60}Co and 17 MeV x radiation is reported. Finally, an explanation is given for the quantitative response of the build up effect under various conditions. (auth)

12937 NEW BIPLANE NEGATOSCOPE MODEL METHOD FOR THE MEASURE OF UNAPPROACHABLE PARTS INSIDE THE LIVING HUMAN BODY AND PARTICULARLY FOR OBSTETRICAL CEPHALO-PELVIMETRY. Caretti, G.; Golfieri, G. (Univ., Bologna). Radiol. Med., 52: 771-96(Aug. 1966). (In Italian).

A model method is described for the radiographic measurement of anatomic parts inside the living human body. The method makes use of two radiograms simultaneously taken at right angle and then placed on a special biplane negatoscope for the determination of the geometric position of the anatomic part of interest. The model may use a mechanical restitution accomplished by means of two groups of tight wires coming out of two simulated focal points or by means of an algebraic formula related to a suitable coordinate system and with the eventual aid of an electronic computer. A practical application for cephalo-pelvimetry during pregnancy is described and possible further applications are suggested. (92 references). (C.H.)

12938 NON-OCCLUSIVE SMALL ARTERIAL ANASTOMOSIS WITH A NEODYMIUM LASER. Yahr, William; Strully, Kenneth J.; Hurwitt, Elliott S. (Montefiore Hospital, New York). Surg. Forum, 15: 224-6(1964).

The use of a laser in a totally nonocclusive technique of vascular anastomosis, to improve blood flow to the vital organs, was investigated. Experimental attempts to create a totally nonocclusive technique resulted in the use of laser energy in conjunction with an adhesive material. The enhancement of laser action by selective stains that affect the relative transparency of tissue was also examined. The neodymium beam focused on ordinary arterial wall produced only superficial coagulation, but when focused on a copper sulfate-stained segment effected complete penetration. Attempts to convert tissues to more perfect black body absorbers with other substances (carbon pigment and graphite) were less successful. (TSS)

12939 ON THE MECHANISM OF RADIOPROTECTIVE ACTION OF CYSTEAMINE ON AN EMBRYONIC ORGAN CULTURED IN VITRO. Kirrmann, J. M. (College de France, Paris). Arch. Sci. Physiol., 20(2): 143-52(1966). (In French).

Portions of intestine of 12-day-old chick embryos were explanted and exposed to x rays in the presence and absence of cysteamine at concentrations of 16 to 64 m$\underline{M}$. Oxygen consumption of the tissue was measured before and after these treatments. Irradiation was performed with 60-kV x rays at 1500 R/min to a dose of 7500 R. Addition of cysteamine to nonirradiated cultures inhibited O consumption (6% at 16 m$\underline{M}$ and 40% at 64 m$\underline{M}$). Irradiation alone diminished O uptake 20% at the dose used. Irradiation plus cysteamine treatment inhibited respiration 1% at 16 m$\underline{M}$ and 38% at 64 m$\underline{M}$ concentrations of the protective compound. Thus the effects of these two agents are not additive, making it evident that the protective action of cysteamine is not uniquely mediated by its inhibition of respiration. However, when cysteamine was added after irradiation, their effects were additive (32% inhibition after 7500 R + 32 m$\underline{M}$ cysteamine). The compound has no effect as a restorative agent of respiration after irradiation. Its protective action when given preirradiation cannot be simply explained on the basis of its reducing ability. (BBB)

12940 STUDY AND APPLICATION OF MACROAGGREGATED ALBUMIN LABELLED WITH ^{131}I. V. PREPARATION OF ^{131}I-MACROAGGREGATED ALBUMIN. Ogawa, Hiroshi; Nitta, Kazuo; Ueda, Hideo; Iio, Masahiro; Kaihara, Shigekoto (Daiichi Pure Chemicals Co., Ltd., Ibaraki, Japan). Yakugaku Zasshi, 86: 20-6(Jan. 1966). (In Japanese).

Techniques are described for synthesizing a new radiopharmaceutical, macroaggregated albumin labeled with iodine-131 (^{131}I-MAA), which has been successfully used as a tracer for pulmonary scanning in man. Previous methods of preparing ^{131}I-MAA have not always been satisfactory from the point of isotope yield and quality for selective pulmonary scanning. Various processes for preparation of MAA were examined with regard to isotope yield and quality for pulmonary scanning. (TSS)

12941 A COMPARISON OF PRETREATMENT WITH POTASSIUM PERCHLORATE AND METHYLTHIOURACIL ON RESULTS OF ^{131}I THERAPY. Buchanan, W. W.; Koutras, D. A.; Crooks, J.; Harden, R. McG. (Western Infirmary, Glasgow). Brit. J. Radiol., 38: 536-40(July 1965).

It was shown that administrations of potassium perchlorate with ^{131}I has no radioprotective effect, of the type found with methylthiouracil, in treatment of hyperthyroidism. Potassium perchlorate is an antithyroid drug which differs from methylthiouracil in chemical constitution and biological properties. The purpose of this investigation was to compare the therapeutic response of 49 thyrotoxic patients to radioiodine after pretreatment with these drugs with the results obtained in 53 patients who had received no previous antithyroid drug therapy. A third group received methylthiouracil. There was no difference in the biological half-lives of the therapeutic doses of ^{131}I in patients who had been pretreated with potassium perchlorate and those who had received no previous antithyroid drug therapy. In contrast, pretreatment with methylthiouracil diminished the therapeutic effects of radioiodine in thyrotoxic patients. In view of this finding, subsequent patients treated with methylthiouracil had their therapeutic dose of ^{131}I arbitrarily increased by one third. By weighting the dose in this way the results in the methylthiouracil-pretreated patients are not significantly different from those obtained in patients without previous antithyroid drug therapy. However, more methylthiouracil-pretreated patients required 2 or more doses of ^{131}I during the first year, although the incidence of hypothyroidism at one year and at the completion of the study was not increased. It is concluded that potassium perchlorate has no radioprotective effect on the thyroid. Thus, this effect of methylthiouracil in the thyrotoxic patient cannot be attributed to that antithyroid action which it has in common with perchlorate and must have a more subtle pharmacological or biochemical explanation. (BBB)

12942 AUTORADIOGRAPHIC STUDIES IN CERVICAL CANCER BEFORE AND AFTER A TEST DOSE OF IRRADIATION. Yanagita, Takao; Herman, Grace G.; Gusberg, S. B. (Mt. Sinai Hospital, New York). Amer. J. Obstet. Gynecol., 95: 1051-8(Aug. 15, 1966).

Autoradiography was used to study the synthesis of DNA and RNA before and after test radiation doses to determine the patterns of synthesis prior to irradiation, effects of such test doses on the synthetic processes, and the relation between nucleic acid synthesis and radiosensitivity of cervical cancer. Tritiated-thymidine and ^{3}H-uridine were incorporated into human cervical carcinoma cells before and after 1600- to 1800-R irradiation. A description of a new short-term incubation method is presented. Higher percentages of labeled cells were found in the uridine series than in the thymidine series both before and after irradiation. Aggregate labeling was more frequent in the uridine series, but occurred on or around the nucleolus with both ^{3}H-thymidine and ^{3}H-uridine. This supports the view that DNA synthesis as well as RNA synthesis takes place on or around the nucleolus. After the test dose of irradiation the percentage of cells synthesizing DNA tended to decrease whereas the percentage of cells synthesizing RNA tended to remain the same, or in some instances increase. These results support the hypothesis that irradiation injury to cells damages the reproductive capacity of the cells and its DNA equivalent differentially at a phase where the protein-forming apparatus or its RNA equivalent is unaffected and even thrives. (BBB)

12943 EXPERIMENTAL RESULTS FROM EXPOSURE OF CLOUDMAN S-91 MELANOMA IN THE CDBA/2F$_1$ HYBRID MOUSE TO NEODYMIUM OR RUBY LASER RADIATION. Minton, John Peter; Zelen, Marvin; Ketcham, Alfred S. (National Cancer Inst., Bethesda, Md.). Ann. N. Y. Acad. Sci., 122: 758-66(May 28, 1965).

Characteristics of the temperature gradient within the tumor at

the moment of laser impact, and a theory that allows prediction of the probability of tumor destruction from laser radiation, are reported on the basis of studies in melanoma-bearing mice. Highly malignant melanoma implants in CDBA/2F_1 hybrid mice were permanently destroyed under certain circumstances by either ruby or neodymium laser radiation. The destructive phenomenon observed was immediate and probably related to a thermal energy transfer from the laser pulse into the tumor. Measurements indicated that temperatures were above 212°F for extremely short periods of time in areas of tumors that were destroyed. Destruction of a given tumor was found to depend on a relation between the dia of the tumor and the amount of laser energy delivered to that tumor and the percentage of laser energy absorbed at a given laser wavelength. A major factor in tumor destruction appeared to be the thermal energy produced during the moment of laser impact. An attempt was made to quantitate the amount of laser energy necessary for permanent tumor destruction of tumors with various sizes. The following equation was derived: $P(x) = 1 - e^{-\lambda x}$, where P denotes the probability of tumor destruction, x is the ratio of laser energy in joules to tumor area, and λ is a quantity termed the coefficient of laser destruction (COLD) which may be calculated from the experimental results. The details on the derivation of the λ values or the COLD are given in an appendix. (BBB)

12944 HYGIENIC PRINCIPLES OF DESIGNING AND EQUIPMENT OF RADON CLINICS AT HEALTH RESORTS WITH RADON WATERS. Gusarov, I. I. Med. Radiol., 11: No. 9, 79-83(Sept. 1966). (In Russian).

A number of health problems arising in connection with the construction of radon clinics at health resorts are discussed. The supply of radon water to the building of the radon clinic, the internal design, sanitary and technical equipment of radon clinics, and the removal of radonactive wastes (liquid and gaseous) from the building of the radon clinic are discussed. (C.H.)

12945 EFFECT OF DESOXYRIBONUCLEIC ACID (DNA) ON SURVIVAL AND RAT LIVER INJURY AFTER IRRADIATION. Bankowski, Zbigniew; Polowiec, Zofia; Steplewski, Zenon; Wilczok, Tadeusz (Pathomorphologic Lab., Warsaw. Inst. of Oncology, Gliwice, Poland). Arch. Immunol. Therap. Exp., 14: 767-73(1966).

The effect of highly polymerized DNA from the thymus of calves on the survival rate of Wistar rats irradiated with a whole-body single dose of 900 γ-rays was the subject of the studies. About 60% of rats receiving each intraperitoneally 3 mg DNA 24 and 48 hrs after irradiation, showed at least 30 day survival, whereas all animals untreated with DNA succumbed within 18 days after irradiation. The morphochemical examinations showed the liver damage to be less extensive in animals treated with DNA. (auth)

12946 FRACTIONATION OF X-IRRADIATED AND PROTECTION WITH PROPYLGALLATE OF DNA ON A CELLULOSE ANION EXCHANGER. Nikolaeva, N. V.; Semenova, L. P.; Kruglyakova, K. E. Dokl. Akad. Nauk SSSR, 169: 1203-5(1966). (In Russian).

The protective effect of propylgallate against x radioinduced fractionation of DNA was studied in a cellulose resin exchanger using solutions of DNA prepared from rat spleen. Doses of 20 and 40 kR x radiation were delivered at the rate of 2320 R/min. Doses of 20 kR induced rupture of DNA spirals and doses of 40 kR induced depolymerization. Chromatographic profiles of the DNA showed that the addition of propylgallate before irradiation protected the high polymer DNA fractions. It was concluded that propylgallate inhibited free radical reactions. The possible use of propylgallate as a protective compound for a wide range of doses is discussed. (R.V.J.)

12947 PREPARATION OF ^{32}P-LABELED RESIN MICROSPHERES FOR RADIATION TREATMENT OF TUMORS BY INTRA-ARTERIAL INJECTION. Caldarola, L. (Inst. of Oncology, Turin); Rosa, U.; Badellino, F.; Sosi, S.; Cavalli, A. Panminerva Med., 7: 102-6(Apr. 1965).

Data are shown for the preparation of ^{32}P-labeled resin microspheres for radiation treatment of tumors by intra-arterial injection. An ion exchange resin can be used as a support for ^{32}P in intra-arterial treatment of malignant tumors. Results show that it is possible to label a cation exchange resin with ^{32}P. This is due to the formation of Cr^{3+} complexes with phosphate ion. The nuclear properties of ^{32}P appear on the whole to be more advantageous than those of either ^{198}Au or ^{90}Y for this specific use. (S.M.H.)

12948 NIGHT-SWEATS IN PATIENTS WITH LYMPHOMATOUS TUMORS: RESPONSE TO RADIOTHERAPY. Logan, J. (Wellington Hospital, New Zealand). New Zeal. Med. J., 65: 313-15(May 1966).

Night sweats decreased in 8 of 10 patients with malignant lymphomas following x-ray therapy to the anterior neck. In 8 of the patients treatment was confined to the thyroid region and in 2 patients wide fields of radiation were used. The dose found to be effective was 500 to 900 rad given in three or four daily sessions. The smallest single dose to cause a noticeable decrease in sweating was 300 rad. It was concluded that night sweats were decreased by irradiation of the thyroid gland. (TSS)

12949 PRETREATMENT WITH SELECTIVE BULBAR-STIMULATING DRUGS (CORAMINE AND MICOREN) AND SURVIVAL OF WHOLE-BODY IRRADIATED MICE. Stuart, C.; Cittadini, G.; Tomiselli, G. (Univ., Siena, Italy). Boll. Soc. Ital. Biol. Sper., 41: 1064-5(Sept. 30, 1965). (In Italian).

Radioprotective activity of Coramine and Micoren were tested in mice of the Swiss strain that were given lethal whole-body doses of 200-kV x rays. Preliminary tests showed the LD_{50} values of the drugs, injected intraperitoneally in mice, to be 230 mg/kg for Coramine and 670 mg/kg for Micoren. The minimally effective pharmacologic doses were 20 and 5 mg/kg, respectively. Doses of 40 mg/kg of each were injected intraperitoneally into mice 25 min before exposure to 600- or 800-R x-ray doses, representing the $LD_{50/30}$ and $LD_{100/30}$ values for these mice. With the $LD_{100/30}$ radiation exposure, neither drug exerted any effect on mortality. However, with the 600-R, $LD_{50/30}$ exposure, Coramine prolonged average survival time to 647 days as compared to a control value of 420 days; Micoren prolonged average survival time to 569 days. These differences are significant at the 99.5 and 95% confidence levels, respectively. These results are in accord with earlier findings on the radioprotective effects of other selective bulbar stimulants. (BBB)

12950 COMPARISON OF SOME BIOCHEMICAL AND HEMATOLOGICAL CHARACTERISTICS DURING RADIATION SICKNESS AND UNDER INFLUENCE OF ALKYLATION AGENTS, ON THE EXAMPLE OF THIO-TEPH. Alesenko, A. V.; Burlakova, E. B.; Dzyuba, N. M.; Slepukhina, L. V.; Emanuel, N. M. (Inst. of Physical Chemistry, Moscow). Radiobiologiya, 6: 718-23(1966). (In Russian).

The changes in the antioxidizing activity of the liver lipids and the changes in the blood system were investigated in mice exposed to x radiation at doses from 350 to 750 R. The mice were injected with 2,4,6-trimethyl-3-hydroxypyridine, thio-TEP, and 4-methyl-2,6-di-tertiary-butylphenol. The results showed that inhibitors, given at doses sufficient to cause antioxidizing activity, can be used as protectors against the harmful effects of alkylation agents and ionizing radiation. (J.S.R.)

Radiation Effects on Animals

Refer also to abstracts 12693, 12787, 12791, 12793, 12807, 12813, 12821, 12822, 12826, 12872, 12904, 12906, 12907, 12914, 12942, 12945, and 13363.

12951 (LA-3610) BIOLOGICAL AND MEDICAL RESEARCH GROUP (H-4) OF THE HEALTH DIVISION ANNUAL REPORT, JULY 1965–JUNE 1966. (Los Alamos Scientific Lab., N. Mex.). July 1966. Contract W-7405-eng-36. 265p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies in cellular radiobiology, molecular radiobiology, mammalian radiobiology, mammalian metabolism, and biophysics. Research problems in cellular radiobiology were: premitotic radiosensitivity of mammalian cells, including timing and dose dependency of the radioinduced G_2 delay, and radiation effects on terminal protein synthesis essential for division; methylation of mammalian DNA; effects of inhibitors of protein and RNA synthesis on regeneration of surface sialic acid in cell cultures; energy metabolism of cultured mammalian cells; design of an automatic cell counter for mammalian cells in suspension culture; intercellular control of development of competence in culture of Hemophilus influenzae by a cell-free product of cell metabolism; and structural changes during acid inactivation of alcohol dehydrogenase in horse liver. Studies in molecular biology included: purification of RNA polymerase from E. coli; enzymatic synthesis of short polydeoxyribonucleotides; simultaneous use of two or more deoxynucleotide 5′-triphosphates for polydeoxynucleotide synthesis with terminal deoxynucleotidyl transferase from calf thymus glands; P^1, P^2-pyrophosphates as initiators in the terminal deoxyribonucleotide transferase reaction; enzymatic synthesis of oligo- and polydeoxynucleotides; the mode of action of nucleases using defined polydeoxynucleotide substrates; chemical synthesis of oligonucleotides; deoxyribonucleotide triphosphate derivatives; oligonucleotide chromatography; organometallic compounds in nucleic acid chemistry; and a computer analysis of uv spectra. Radiobiological investigations in mice were aimed at determining: total dose effect on survival; injury and recovery of bone marrow during and following continuous low-intensity γ-irradiation; comparative after-

survival time following graded first and graded but reversed second exposures; and the effective residual dose concept of radiation injury. Metabolism of ^{137}Cs, ^{110}Ag, ^{109}Cd, and ^{133}Ba was studied in various mammals. Biophysical research was concerned with: in vivo measurement of ^{239}Pu body burdens in man; development of a cell separator; detection of cells by light-scattering; volume distribution of normal human erythrocytes, and leukocytes, and of mouse bone marrow; and computer analysis of amino acids. Abstracts of publications and manuscripts submitted during the report period are included. (H.G.D.)

12952 (UCRL-16898) BIOLOGY AND MEDICINE. Semi-annual Report, Fall 1966. Lawrence, John H. (ed.) (California Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 141p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared on 15 sections of this report. A list is included of 32 publications during the period covered. (C.H.)

For abstracts of individual sections see: 12290, 12753, 12809, 12810, 12953, 13073–13075, 13351, 13352, and 14135–14139.

12953 (UCRL-16898, pp 22-41) EFFECT OF ERYTHROPOIETIN ON THE GROWTH AND DEVELOPMENT OF SPLEEN COLONY-FORMING CELLS. Schooley, John C. (California Univ., Berkeley. Lawrence Radiation Lab.).

The development of erythroid colonies in the spleens of lethally γ irradiated mice following bone marrow transplantation was suppressed by the production of polycythemia or the injection of antibody against erythropoietin into the host mice. The injection of exogenous erythropoietin into nonpolycythemic animals did not increase the number of spleen colonies produced by a bone-marrow transplant. The injection of exogenous erythropoietin into polycythemic host mice in some experiments did not significantly alter the number of colonies produced by a bone-marrow transplant, whereas in other experiments a marked increase in the number of spleen colonies occurred. The discrepancy between these experiments is discussed. The overall doubling time of colony-forming cells in the spleens of polycythemic mice was not altered by the injection of exogenous erythropoietin during the first 10 days after bone marrow transplantation. Some evidence is presented suggesting that the doubling time of colony-forming cells in polycythemic mice receiving erythropoietin was maintained equal to that observed in polycythemic mice not receiving erythropoietin by some change in the proliferation of colony-forming cells. Arguments are presented suggesting that erythropoietin does not act on the colony-forming cell directly, but upon some erythropoietin-sensitive cell derived from the colony-forming cell. (auth)

12954 RADIATION HAZARDS IN PERSPECTIVE: THIRD REPORT OF THE EXPERT COMMITTEE ON RADIATION. Adrian, Lord. World Health Organ., Tech. Rep. Ser., No. 248, 37p(1962).

The extent of radiation hazards in man's environment was considered and recommendations were made for reducing some of them. Also discussed were some problems confronting public health authorities in determining how radiation protection should best be fitted into public health programs. It was emphasized that maximum use of the knowledge gained from intensive studies in the radiation field should be applied to other comparable public health hazards. This might be achieved by comparing data on the somatic and genetic effects of ionizing radiation with information on other agents and substances in our environment having toxic, carcinogenic, or mutagenic properties. Exposure to low doses of radiation is considered in relation to hereditary effects, cancer, and leukemia. For toxic substances, the risk has been even less well estimated than for radiation. For radiation exposures, cancer, leukemia, and genetic effects are presumed to occur in small proportions of individuals exposed to levels below those that regularly cause early pathological effects, and there is presumably no threshold dose for genetically determined changes. However, it is stressed that mutations due to the natural background radiation can only represent a small fraction of the total number of spontaneous mutations. The Committee recognized that risks are an unavoidable accompaniment of developments in medicine and technology, and that a balance is essential to placing the hazards of radiation and of toxic materials in perspective. It was noted that protection procedures were developed to a much greater extent against radiation hazards than against other toxic agents. The Committee therefore recommended that studies be undertaken to establish criteria for safe exposure levels to these agents, both for individuals (as in the case of occupational exposure) and for populations (as in the case of pollution of water, food, and air). The Committee also recommended that WHO continue to encourage such efforts at the national level, and stimulate and co-ordinate them at the international level. (BBB)

12955 DIFFICULTIES AND PROBLEMS IN THE ASSESSMENT OF THE GENETIC HAZARDS OF RADIATION EXPOSURE. Fritz-Niggli, H. (Univ., Zurich). Roentgenblatter, 18: 385-99 (1965). (In German).

A review of the pertinent experimental data leads to the conclusion that a general rule for an estimate of the danger from genetic radiation exposure of man cannot yet be established and, therefore, no maximum permissible dose can be set. It is suggested that estimates of this type are more dangerous than useful. A quantitative statement, e.g., the quotation a doubling dose, may be given only with a statement of the irradiation conditions, such as dose of radiation and the germ cell stage at exposure and does not permit any generalizations. The problem, however, is simplified by considering the fact that a very low dose of radiation may cause a mutation and therefore also represent a lethal factor. An example is given in the loss or increase of chromosomes which may be released by negligible amounts of radiation in the zygotes of mammals. A chromosome disorder of this type (the triple instead of double presence of a small chromosome) in humans causes mongolism. Thus, negligible amounts of radiation may increase the probability that mongoloids are born. The conclusion drawn from this discussion is that any unnecessary irradiation of the human gonads must be avoided. Maximum permissible doses are misleading and provide false security. (BBB)

12956 PUBLIC HEALTH AND THE MEDICAL USE OF IONIZING RADIATION: FIFTH REPORT OF THE EXPERT COMMITTEE ON RADIATION. World Health Organ., Tech. Rep. Series, No. 306, 41p(1965).

The hazards of ionizing radiation including a comparison of radiation- and chemical-induced toxicity, carcinogenesis, and mutagenesis, and a discussion of the life-shortening action of radiation were surveyed. Recommendations are made for lowering patient and personnel exposure in diagnostic and therapeutic radiology. (TSS)

12957 HAZARDS OF TOTAL CYSTECTOMY AFTER SUPERVOLTAGE IRRADIATION OF THE BLADDER. Higgins, P. M.; Hamilton, R. W.; Hope-Stone, H. F. (London Hospital). Brit. J. Urol., 38: 311-18 (June 1966).

Radioinduced complications in patients undergoing surgical removal of the bladder following ^{60}Co teletherapy are reported. Of nine patients submitted to cystectomy after a full course of irradiation, three died in the postoperative period. The three deaths in the irradiated group were all associated with leakage from the ureterocolic anastomosis, and of the six survivors in this group three developed leakage that subsided with treatment. This contrasted with the 11 patients in the nonirradiated group in which only one death could be attributed to leakage from the ureterocolic anastomosis. In eight of the irradiated patients, a tumor dose of 5000 to 5500 R was given over a 4-week period, using a 3-field pin and arc (one anterior and two posterior) technique. The field sizes were from 6 by 6 to 10 by 10 cm. Total cystectomy was undertaken from 5 months to over 2 yr after completion of radiotherapy. In all cases the urine was diverted by bilateral ureterocolic anastomosis performed with one exception at the same operation. Leakage from the ureterocolic anastomosis occurred early in the postoperative period and was usually associated with ileus. In three cases septicemia and subsequent circulatory collapse supervened, leakage occurring between the third and the tenth day. Necrosis had occurred at the ureterocolic anastomosis, and in one case the colon had perforated at a point close to the anastomosis. The ureters revealed extensive fibrosis in the subepithelial and muscular layers together with vasculitis and a low-grade inflammatory response. Giant fibroblasts were also noted, a finding taken as specific evidence of radiation damage. A degree of vasculitis consistent with irradiation damage was also present in the colon. Occurrence of leakage from the ureterocolic anastomosis was not influenced by the length of time since irradiation. Difficulty in the healing of tissues after radiotherapy is discussed. Irradiation can cause abnormal maturation of fibroblasts, a gradually developing fibrosis and endarteritis, which inevitably leads to a relative ischemia of the part. It is concluded that the lower end of the ureter should not be used for uretero-intestinal anastomosis in these circumstances, and suggestions are made regarding alterations in operative technique. (BBB)

12958 SUMMARY REPORT ON DISORDERS NOTED AMONG A-BOMB EXPOSED WOMEN. Tabuchi, Akira; Nakagawa, Shigeru; Hirata, Masahi; Sato, Hideo (Hiroshima Univ.). Hiroshima J. Med. Sci., 15: 1-23 (Mar. 1966).

Sixty-nine reports relating to after-effects in female survivors of Hiroshima and Nagasaki were surveyed. There were 50% of exposed women with transient amenorrhea. In a study of 1,000 girls exposed within 2 km from the hypocenter and 993 controls, the mean age of menarche among exposed girls was 14.71 and that of the controls 14.57. The number of pregnancies among those who had married after exposure was slightly less than a group of non-exposed controls, but the difference was not significant. There ap-

peared to be a slight increase in the incidence of disorders in the offspring of exposed women after the bombing, but this was felt to be due to the poor environmental condition of the mother following exposure, rather than being a genetic disturbance caused by radiation. (TSS)

12959 LEUKEMIA AUTOPSIES IN JAPAN. Seno, Satimaru; Monden, Hisashi; Shibata, Takashi; (and others) (Okayama Univ., Japan). Acta Med. Okayama, 18: 45-52(Feb. 1964).

To determine whether the annual increase of leukemia incidence in Japan is due to irradiation or some other leukemogenic factor, or due to the increased detection rate, a statistical survey of autopsy cases was made in which the diagnosis was reliable and no types of leukemias escaped detection. The results showed that acute leukemias, which are found mostly in younger age groups, are, in fact, increasing in incidence. It is suggested that, among the suspected etiologic factors, an increase in ionizing radiation exposure is one of the most probable factors responsible for the increase in leukemia incidence in Japan. It is also suggested that observations conducted on the incidence of leukemias both before and after the nuclear fission was discovered may contribute to the answer to the question of whether or not ionizing radiation is a probable cause. The curve of leukemia incidence in Japan shows a progressive increase in the incidence, with a sharp rise after the Second World War. In the earlier period the increase was slow and gradual but in the later period it has been steep. In the period before the War the gradual improvement in diagnostic methods might have been responsible for the increase, but after the War a social security system was set up in Japan, especially in the last several years, so that the increasing rate of detection of leukemia would not appreciably affect the statistical data. The incidence of leukemia in Japan in 1957 was about 2.5 times that in 1947. During the same decade there was an increase of leukemia incidence of about 1.6 times in the U.S.A. and Canada, and about 1.4 times in England and Denmark. (BBB)

12960 RETROSPECTIVE SURVEY ON MEDICAL IRRADIATION AND LEUKEMOGENESIS IN JAPAN. Kitabatake, Takashi (Aichi Cancer Center Hospital, Nagoya, Japan). Tohoku J. Exp. Med., 90: 25-34(1966).

Whether medical irradiation contributes to induction of human leukemia was investigated by questionnaire in 411 hospitals in Japan. History of therapeutic irradiation was significantly more frequent in leukemic patients than controls. The integral bone marrow dose received during fluoroscopy and radiotherapy was calculated. The average bone marrow dose was estimated to be 2704 grad in leukemic patients and 762 grad in controls. Results of this survey indicated that prior radiotherapy could be related to leukemogenesis. (TSS)

12961 BILATERAL MASSIVE ADRENAL HAEMORRHAGE AS A CAUSE OF POSTOPERATIVE DEATH. Schofield, Philip F.; Fox, H. (Manchester Royal Infirmary, Eng.). Amer. J. Surg., 111: 591-4(Apr. 1966).

A case of postirradiation enteritis is described wherein surgical intervention to explore the radiation-induced intestinal injury was followed by fatal hemorrhage of both adrenal glands. The 48-yr-old male patient was first found at cystoscopy to have a tumor of the bladder measuring 5 cm in dia. The tumor proved on histologic examination to be a squamous cell carcinoma. It was treated by external x-ray therapy. After radiotherapy, except for some frequency of micturition, the patient was well for a year, then had a 3-day period of absolute constipation and severe colicky central abdominal pain. On examination he appeared dehydrated, the abdomen was distended, and there was visible peristalsis. Tenderness was present in both iliac fossae as well as extreme tenderness of the pelvic peritoneum. At operation, generalized peritonitis was found, and the terminal 60 cm portion of the ileum was adherent to the pelvic organs and was obviously necrotic. The affected gut was dissected free from the pelvis, and the terminal 90 cm of the ileum together with the cecum was resected and end-to-end ileocolic anastomosis performed. On pathologic examination of the resected specimen, the terminal 90 cm of ileum showed patchy radionecrosis of both the mucous and muscle coats with gross submucosal edema and extensive polymorphic infiltration. In some areas fibrosis of the submucosa and subserosa was evident. The appearance suggested ischemic necrosis resulting from irradiation. After operation the patient suddenly went into shock with a dramatic fall of blood pressure to unrecordable levels and died. At autopsy the bladder wall was fibrous and thickened although there was a large area of sloughing necrosis in the mucosa of the posterior wall of the bladder. The adrenal glands were both extremely large with tense capsules, and there was massive hemorrhage into both glands. A review of the literature showed that postirradiation enteritis may occur at various intervals after radiotherapy, varying from a few months to many years. As in the case described here, the usual presentation is that of intestinal obstruction. Massive bilateral adrenal hemorrhage may have been a response to the extensive radioinduced injury to the bowel. (BBB)

12962 SENSITIVITY OF MAMMALIAN CELLS FOR X IRRADIATION. Vos, O. (National Defence Research Organization TNO, Rijswijk, Netherlands). Boll. Soc. Ital. Biol. Sper., 41: 21 (Oct. 31, 1965).

Various aspects of radiosensitivity of cells in culture or in the intact animal are reviewed. Parameters used to estimate cellular radiation sensitivity are listed. The question of the cellular radiation target is discussed. Much circumstantial evidence indicates that DNA is the primary target in the cell; however, the initial damage to DNA in the animal cell has not been sufficiently investigated. Although differences are found in survival curves of various mammalian cell types, the resemblance of the various curves is more striking than their divergence. A survey of some LD data for various species published in the literature is given in a table. The effect of oxygen on radiosensitivity and results with radioprotective agents are also reviewed. The influence of mitotic phase of the cell at the time of irradiation and of dose fractionation is considered. The methods used for the determination of cellular recovery are essentially the same as those used for the in vitro and in vivo determinations of radiation survival after a single dose, and are discussed. (TCO)

12963 RADIATION-INDUCED PERIPHERAL NEUROPATHY. Stoll, Basil A.; Andrews, John T. (Peter MacCullum Clinic, Melbourne). Brit. Med. J., 1: 834-7(Apr. 2, 1966).

With megavoltage x-ray machines, peak dosage is below the skin. The 117 female patients surveyed were given megavoltage x-ray therapy within 3 to 10 weeks after radical mastectomy. They were treated by a 4-MeV linear accelerator over an irregularly shaped field measuring 15 by 5 cm, to include the scalene, supraclavicular, and axillary lymph node areas. Doses delivered to an anteriorly placed field were 6300 rad in 12 increments in 25 to 26 days in 33 cases, and 5775 rad in 11 or 12 increments in 25 to 28 days in 84 cases. Initial neurological symptoms were not noted earlier than five months or later than 30 months after irradiation. After 6300 rad, neurological symptoms were complained of by 24 out of 33 patients (73%), and in the group receiving 5775 rad, 14 out of 84 patients (15%). The higher-dose group tended to show initial symptoms earlier than the lower-dose group. Of the 21 patients receiving 6300 rad available for neurological examination, 17 had neurological symptoms and abnormal neurological signs, which were severe (grade 3) in six; two showed abnormal neurological signs only and did not complain of symptoms (grade 1); and two had neither symptoms nor signs. Of those receiving 5775 rad, 13 presented symptoms and abnormal neurological signs, which were severe in only one. The signs were as often motor as sensory, and usually mixed sensory, motor, and reflex changes were elicited. Necropsies performed on two patients showed macroscopically marked fibrosis surrounding the nerves of the brachial plexus. Microscopical examination within the area of fibrosis showed a varying degree of fibrous thickening of the neurilemma sheath, demyelinization, and fibrous replacement of some nerve fibrils. In 139 patients treated by orthovoltage (200-kv) x rays with small fields (4 by 6 cm) to the apical axilla with a tumor dose of 4300 to 5300 rad in 25 to 28 days, neuropathic symptoms were noted in 10% of cases. The min dose associated with neuropathy was 4350 rad in 10 increments in 25 days. (TCO)

12964 OPTICAL MASERS (LASERS). Ham, William T. Jr.; Williams, R. C.; Geeraets, W. J.; Ruffin, R. S.; Mueller, Harold A. (Medical Coll. of Virginia, Richmond). Acta Ophthalmos., Suppl. 76: 60-78(1963).

Fundamental aspects of the ruby laser are reviewed and experiments on the effects of laser radiation on the retina are reported. A laser system suitable for a quantitative investigation of irreversible thermal damage to the rabbit or human retina is described. The thermal dose required to produce irreversible damage to the retina was investigated, the threshold dose being defined arbitrarily as the appearance of ophthalmoscopically observable lesions at 5 min after exposure. These lesions, while mild, do not represent the minimum irreversible damage which can be observed. The thermal dose for irreversible damage to the retina is ~0.3 cal/cm^2 or less, and laser burn thresholds approach asymptotically a value of 0.15 to 0.20 cal/cm^2. Factors influencing the threshold dose for irreversible damage to the retina discussed are the transmission of radiation through the ocular media (OM) and its absorption in pigment epithelium (PE) and choroid (CH) as a function of wavelength. For the ruby laser, emitting at 694.3 mμ, transmission through the OM is about 95%. Absorption of thermal radiation in the PE is the determining factor in the production of threshold lesions. Therefore, absorption in the PE as a function of wavelength has an important role in estimating the susceptibility of the human retina to thermal injury.

Absorption vs wavelength was investigated in 24 human eyes. In general, the max variation in absorption among these 24 individuals (Whites and Negroes) was about 30% in the spectral interval 450–1300 mμ. The narrow series of lines centered at 1060 mμ for neodymium lasers have an absorption for OM + PE which varies from about 3% to 15% depending upon the individual. Thus, the eye has some self-protection for this wavelength but the energy/pulse from neodymium lasers makes them exceedingly hazardous in spite of the relatively low absorption in the PE. For 694.3-mμ emission from ruby lasers, absorption in the PE varies from 15 to 40% depending on the individual. Ruby is more dangerous than neodymium; lasers with outputs in the spectral range 700–500 mμ would be still more dangerous from the standpoint of thermal injury to the human retina. (BBB)

12965 REACTION OF NEOPLASM AND BRAIN TO LASER. Rosomoff, Hubert L.; Carroll, Fred (Univ. of Pittsburgh). Arch. Neurol., 14: 143-8(Feb. 1966).

Effects of laser radiation on the brain of dogs and rats and on human brain tumors were studied. In normal animal brains, lesions were created which were hemorrhagic in a background of almost total cellular destruction and vacuolization suggestive of vaporization. Surrounding reaction to injury was minimal. Sensitivity to laser was enhanced by previous intravascular injections of Cardio-green or Evans blue and by the topical application of carbon dust. In human tumors, near total cellular necrosis was produced; hemorrhage and inflammation were not observed. Penetration could be achieved through tumor, whereas normal brain was resistant, implying a differential susceptibility to laser. In man, laser was well tolerated, painless, and extraordinarily large doses of energy could be delivered without an adverse systemic effect. However, potential therapeutic application is limited until laser technology is more advanced and until basic mechanisms of action, reaction, and efficient utilization are explored further. Future research should be directed toward finding the threshold of laser sensitivity for specific cell types or tissue systems. Possibilities raised by the direct application of photochemical principles to this problem are discussed. This should allow the use of lower output lasers where tissue may be affected differentially but not be totally destroyed, as is occurring presently. The effect may also become highly selective in that interference might be produced in specific metabolic reactions or enzyme systems by precision target control achieved by the combination of a dye intermediary and specific wavelength laser. (BBB)

12966 DEPRESSION AND RESTORATION OF THE REGENERATIVE CAPACITY OF THE PERIPHERAL NERVE AFTER X-RAY APPLICATION. Streline, G. S.; Evsukov, V. I. (Central Inst. of Roentgenology, Leningrad). Biol. Med. (Paris), 54: 466-76(July-Aug. 1965). (In French).

Regeneration of sectioned sciatic nerve was studied in male Wistar rats 24 hr after receiving x-rays to the whole body (600 R) or to the corresponding hind limb (600, 1500, 3000 R). In other groups the nerve was sectioned 20, 60, or 127 days after 3000-R local irradiation. No effect on regeneration of the nerve was noted after 600-R local or whole-body irradiation. However, local doses of 1500 and 3000 R significantly inhibited nerve regeneration. Irradiation of the spinal cord with 3000 R at the level of the corresponding sectioned nerve did not inhibit its regeneration. It is suggested that the inhibition of regeneration after irradiation at high doses, depends on the connective tissue around the nerve and the Schwann syncytium, not the axons. The differences observed between the regeneration of nerve and that of other tissues can be attributed to the proliferative capacity of the various types of cells involved. (BBB)

12967 IMMUNOLOGIC ASPECTS OF RADIATION INJURY AND CANCER THERAPY. Harrington, William J. (Univ. of Miami, Fla.). Ind. Med. Surg., 35: 582-3(July 1966).

Chronic myelocytic leukemia is suppressed by ionizing radiations (or radiomimetic alkylating agents) and antimetabolites which block specific steps in cell biosynthesis. Relapse soon follows discontinuance of the latter while remissions characteristically persist for months or years after irradiation. New antigens have been demonstrated in blood cells following irradiation but not drug therapy, by complement-fixation, immunoprecipitin, and antiglobulin tests. Immunologic response appears to be superimposed upon acute tissue injury to account for the protracted effects of radiation. Some observations on experimental animals or patients with leukemia are described. Active immunization to cells from subjects treated with radiation may cause increased susceptibility to the cytopenic effects of these agents. Transfer with lymphoid cells or plasma of this sensitivity may be possible. Protection by immunosuppressive agents or by immunologic tolerance induced in neonates with marrow from treated adults is also considered, as is accentuation of cytopenic effects by augmentation of immunologic competence with phytohemagglutinin. The new antigens appear to represent mutations. Transfer to remote cell populations of new genetic information could explain the lasting systemic effects of local (e.g. splenic) irradiation. To test transformation, CBA and Ajax mice were used. Intravenous neonatal injection of isogenic fetal skin grown in tissue culture with allotypic DNA provided up to 4-fold prolongation of homograft survival, supporting the possibility of in vivo transformation. Moderation of mass radiation injury by immunosuppressive agents might improve survival rates, while possibly rendering the exposed more liable to the development of myelocytic leukemia. (BBB)

12968 ANTIBODIES TO X-IRRADIATED RABBIT TESTES. Hook, W. A.; Muschel, L. H.; Faber, J. E. (Walter Reed Army Inst. of Research, Washington, D. C.). Immunology, 10: 245-8 (Mar. 1966).

Testicular extract was used as a complement-fixing antigen to determine whether exposure of testes to x rays increases natural antibody levels in rabbits. In addition, antisera prepared by immunizing rabbits with isologous and autologous testis antigens were used to compare immunological properties of antigens obtained from normal and irradiated testes. Adult, male New Zealand white rabbits were exposed to 500 R whole-body radiation or to 2000 R to the testes only. Antigen was extracted from testes obtained 2, 10, or 42 days after 2000 R. Rabbits exposed to 500-R whole-body irradiation showed a two-fold decline of natural antibody 1 to 3 weeks after irradiation, as seen in tests with normal as well as irradiated testes antigens. Titers returned to pre-irradiation levels by the fourth week. Serum from rabbits given 2000 R to the testes and from nonirradiated controls exhibited relatively constant levels of natural antibody. There was no suggestion that x-ray injury of testes resulted in increased amounts of antibody to that tissue. Furthermore, antigens extracted from irradiated testes were no more sensitive for detecting natural antibody in irradiated animals than were antigens obtained from nonirradiated rabbits. When antigens from normal and irradiated tissue were titrated with the antisera made against these antigens, titers of 10- and 42-day post-2000-R testis extracts were lower than titers of antigens extracted from 2-day post-2000-R and nonirradiated testes. Anticomplementary activity of 10- and 42-day antigens was less than that of 2-day or nonirradiated testes. No evidence was obtained to indicate that radiation-altered tissue acquired new antigenic determinants which were immunologically foreign to its host. In addition, relative immunological unresponsiveness of the rabbit to its own tissue did not seem to be broken by irradiation. Therefore, irradiation did not induce autoantibody formation either by altering tissue antigens or by breaking down the unresponsiveness of the antibody-forming system. (BBB)

12969 EFFECT OF X-IRRADIATION ON LIVER REGENERATION. Clerici, Enrico (Univ., Milan); Cammarano, Piero; Mocarelli, Paolo. Exp. Mol. Pathol., 5: 389-95(Aug. 1966).

The in vivo incorporation of DL-leucine-1-^{14}C into the total protein of cell fractions in liver was studied in partially hepatectomized and sham-operated Wistar rats given 1000-R whole-body x irradiation within the presynthetic period, and sacrificed at different intervals after x irradiation. In both partially hepatectomized and sham-operated rats the highest specific activity was found in microsomes, followed by mitochondria, supernatant, and nuclei, and the specific activity of each fraction, except the nuclear one, ranged above that of the whole homogenate. In the early phase of liver regeneration protein synthesis was significantly increased only in the microsomal and, to a lesser degree, mitochondrial fractions, while it was depressed in the nuclei, as compared to sham-operated controls. During early stages of liver regeneration, whole-body x irradiation inhibited incorporation of leucine into the soluble protein fractions, i.e., prevented the increase of metabolic activity expected 16 hr after partial hepatectomy. It also blocked the increase of protein synthesis in microsomes. Thus, irradiation during the early stages of liver regeneration prevents the synthesis of protein molecules which are either necessary to overcome the parenchymal tissue loss or which pass into the blood stream after synthesis by liver cells. The effects of irradiation are attributed to disturbances in the synthesis or turnover of nuclear RNA's acting as templates in the production of the new protein molecules necessary to support liver regeneration. (BBB)

12970 THE REPRODUCTIVE CAPACITY OF ARTEMIA SUBJECTED TO SUCCESSIVE CONTAMINATIONS WITH RADIOPHOSPHORUS. Grosch, Daniel S. (North Carolina State Univ., Raleigh). Biol. Bull., 131: 261-71(Oct. 1966).

Studies of Artemia populations exposed to ^{32}P described here revealed persistent inferiority of reproductive performances in pair matings, and indicated that species density data can be misleading. Results suggested that: although adults in an experimental culture may be abundant, their reproductive potential may be inadequate to withstand further damage by radiations; and although the number of adults seen in mass cultures may be equivalent, subcultures of

control and experimental strains react differently to radioisotope additions. Strains descended from ancestors exposed to ^{32}P did not necessarily survive a second dose even though total dosage does not exceed the extinction dose given as a single addition. It was found that a period of recovery involving a passing of generations must intervene. Pair mating tests revealed that in comparison with controls, experimental strains: have a shorter life span; deposit fewer zygotes per brood; deposit more of their developed zygotes as viable cysts; and show poor survival to adulthood except when crowding is mitigated by low fecundity. Because the frequency of brood deposit was regular in both control and experimental Artemia strains, an increase in total progeny accompanied increased life span. Sex ratios among adult progeny from pair matings favored females in all strains. It was proposed that the proportional number of larvae surviving to adults may be critical in determining whether or not a strain can tolerate another exposure to a radioisotope. (BBB)

12971 RADIATION STUDIES WITH THE BOLL WEEVIL: LETHAL EFFECTS ON LARVAE; PUPAE; AND ADULTS; MALE STERILITY AND DOSE FRACTIONATION. Flint, Hollis M.; Bibow, William R.; Lahren, Cheryl K. (Dept. of Agriculture Entomology Research Div., Fargo, N. Dak.). J. Econ. Entomol., 59: 1249-55(Oct. 1966).

To investigate the problem of sterilizing the boll weevil with radiation, studies were done at low dose levels to determine the maximum amounts of x irradiation that larvae, pupae, and adults could tolerate. All three forms of Anthonomus grandis were found to be very sensitive to x rays, as measured by adult survival 3 weeks after irradiation. Adult survival of 50 to 70% three weeks after treatment was considered the minimum acceptable level. Doses of x rays that met this criterion were 1200 R for last-instar larvae, 2400 R for late-stage pupae, and 3200 R for adults. In adult weevils, mortality occurred 7 to 14 days after irradiation, and the death rate did not increase when doses were increased from 3200 to 15,000 R. Male weevils were 90 and 99% sterilized by doses of 7500 and 9000 R, respectively. No sterilized male lived more than 3 weeks, and no increase in fertility occurred. In a test with mixed populations of adults irradiated with doses up to 4800 R, a significant increase in fertility occurred during the 3-week test period, but 5 days after doses of 4000 R or more, egg production was almost eliminated. No increased survival occurred when an 8000-R dose was administered in 4 fractions of 2000 R each to adults at intervals between fractions of as much as 48 hr. Both the lethal and sterilizing effect of x rays was reduced when weevils in the larval, pupal, and adult stages were sequentially irradiated with fractionated doses, indicating that dose fractionation is not a promising means of producing a sterile and viable weevil. (BBB)

12972 MODALITY IN THE MANAGEMENT OF SECONDARY CATARACTS. Clark, William B. (Victor C. Smith Memorial Eye Clinic, New Orleans). Amer. J. Ophthalmol., 61: 1081-3 (May 1966).

The use of x radiation to treat secondary cataract is described, particularly with respect to prevention of radioinduced complications. Secondary cataract associated with Elschnig's pearls occurs most often today in the child who has had a needling, or a combined needling and linear extraction, for congenital cataract. Experiments and clinical studies are discussed that are related to the radiosensitivity of ocular structures. Attempts were made to destroy the viable cells of lenses with secondary cataract complicated by Elschnig pearls in children, before breaking up the pearls and washing them out of the anterior chamber. In a few instances, it was possible to detect the development of the pearls before they blocked the visual axis, and it was from these cases that it was learned that treatment of the lens with x rays would kill the viable cells. The production of pearls stopped in these cases. X radiation was administered at 100 R given at weekly intervals for four treatments. Proliferation of the pearls was checked. (TSS)

12973 OBSERVATIONS OF THE EPIDERMAL ULTRASTRUCTURE AND SUBEPIDERMAL NERVES BEFORE AND AFTER X IRRADIATION. PART II. Hagen, E.; Werner, S. (Univ., Bonn). Arch. Klin. Exp. Dermatol., 225: 328-34(1966). (In German).

After exposure to single 20 R doses of x radiation the myelin sheaths of the nerve fibers within the sensory bodies showed evidence of histological damage. The structure as seen ultramicroscopically as well as by means of the light microscope was similar in both the termination of an autonomic nerve fibre and in sensory, cerebrospinal nerve fibers of the skin. The changes produced in the myelin sheath consisted of loosening of the lamellar structure, accompanied by increasing widening of the perilamellar splitting that was produced. The axon developed an irregular contour. It was impossible to resolve the question whether there was any major difference between autonomic and cerebrospinal fibers in the skin. (TSS)

12974 SCINTILLATIONS IN LIVING NERVE INDUCED BY β-RADIATION OF TRITIUM. Kallay, N.; Tigyi, J. (Medical Univ., Pecs, Hung.). Acta Biochim. Biophys., Acad. Sci. Hung., 1: 101-6(1966).

Sciatic nerves of frogs (Rana esculenta) were incubated in Ringer's solution containing 0.1 mCi/ml tritiated water, and the scintillation induced by the β-radiation in the nerve tissue itself was measured by a photomultiplier. The tritium-treated nerves were compared with untreated ones. A significant increase in scintillations was detectable in the nerves containing tritium. The β-counting efficiency of the nerves was calculated as 0.05%. The measurement of scintillations induced by ionizing radiation in living tissues offers a new methodological possibility to investigate the changes and amount of natural scintillating substances. The β particle of tritium was chosen because its energy is ~18 keV, and does not generate Cherenkov radiation in the water that makes up about 80% in the nerve tissue. The velocity of these electrons is 8.1×10^9 cm/sec. This allows calculation of the necessary optical refractory index to create Cherenkov radiation. The calculation gives an optical refractory index $n = 4$, so it is possible to exclude the role of Cherenkov radiation in the effect measured here. (BBB)

12975 GENETIC MECHANISMS OF AGING. Sinex, F. Marott (Boston Univ.). J. Gerontol., 21: 340-6(July 1966).

Speculations advanced at a conference on causes of aging are reported, some of them entailing radiobiological mechanisms. Mechanisms of radioinduced aging are discussed, and the effectiveness of cytotoxic and radiomimetic drugs in stimulating age-dependent deterioration are compared. (TSS)

12976 RADIOTHERAPY. Windeyer, Brian. Trans. Med. Soc. London, 81: 14-20(1965).

Radiosensitivity, radioresistance, effects of ionizing radiations on normal and tumor cells, and complications of radiotherapy are reviewed. Factors that influence radiosensitivity and radioresistance, including degree of oxygenation of the tissues, bacterial infection, involvement of bone and cartilage, and acquired radioresistance due to previous irradiation, are discussed. (TSS)

12977 EFFECTS OF X-IRRADIATION ON THE DEVELOPMENT OF THE RESPIRATORY SYSTEM AND SURVIVAL TIME IN PUPAE OF SARCOPHAGA PEREGRINA. Sato, Chikako (Tohoku Univ., Sendai). Tohoku J. Exp. Med., 90: 1-8(1966).

The oxygen uptake in the pupal stage of the fly Sarcophaga peregrina is characterized by a U-shaped curve, and its ascending limb is inhibited by irradiation. Since the inhibitory effect of irradiation on respiration parallels that of morphological development, it should be possible to estimate quantitatively the radiation effect on development by measuring the oxygen uptake. An attempt was made to define the pattern of radiation effects upon the development of pupae with reference to radiation dose. The pupae received 1.4- to 69-kR doses of x rays in the early pupal stage, and oxygen consumption was measured throughout the pupal stage. Three patterns of radiation effects were found according to the dose. With small irradiation doses an inhibitory effect on oxygen uptake was evident, but the survival time of the pupae was the same as that of nonirradiated, nonfed pupae. With medium radiation doses, oxygen uptake of the pupae was maintained at an extremely low level throughout the pupal stage, but they survived far longer than the nonirradiated control pupae. With large radiation doses, oxygen uptake was exponentially reduced after irradiation, leading to death in the early pupal stage. The outstanding feature of these experiments was the finding that the pupae irradiated at medium doses survived longer than control pupae. (BBB)

12978 POISONED BY THE SUN. PHOTOSENSITIVITY CAUSED BY OUR ENVIRONMENT: DRUGS: COSMETICS, PLANTS, AND OTHER CONTACTS. Epstein, Stephan (Univ. of Wisconsin, Madison). Med. Times, 93: 253-66(Mar. 1965).

The effect of uv light on skin and its action as a photosensitizer in causing dermatitis are reviewed. The uv-photon may directly affect some component of the skin and turn it into a poisonous product, or the effect may be indirect: the photon may hit a photosensitizer. This is a chemical compound that absorbs only partially the energy of the photon and reflects the remaining energy on some other molecule in the skin. This indirect action is referred to as photodynamic action. Photocontact dermatitis is either of allergic origin or simply the product of a toxic process; both photo-allergic and phototoxic mechanisms are considered. Drugs are the major cause of photosensitivity reactions. Some drugs that absorb light transform it into a different wavelength. When reflected light is absorbed, it causes a toxic reaction in the form of a sunburn or pigmentation or both. Such phototoxic reactions from drugs are rare. If the cause of a photocontact dermatitis is found, and the contact eliminated, then, in most cases, the dermatitis will

disappear promptly. But there are instances where the dermatitis continues even though the offending photosensitizer has been completely eliminated. An autosensitivity reaction is proposed to explain this phenomenon. Diagnosis of photosensitivity by patch testing and its treatment are also described. (BBB)

12979 CONCERNING THE EFFECT OF X-RAYS ON LIVING TISSUES. Lespine, J. (Ecole Odontologique, Paris). Rev. Belge. Med. Dent., 20: 137-49(1965). (In French).

The extent of population exposure to radiation from dental radiography and oral radiotherapy is assessed, possible hazards of such irradiation are reviewed, and preventive means cited. Reduction of doses in diagnostic procedures can be accomplished by proper selection of kilovoltage and filters, and use of lead diaphragms, high-speed films, and optimum development time. Use of ionizing radiation to treat benign lesions of the oral region is criticized. The hazards of late changes, particularly carcinogenesis, as a result of such treatments with x rays and Ra are described. Development of radioepithelitis as a result of irradiation of the sensitive buccal mucosa is also described in a stepwise fashion. Replacement of normal epithelium by fibrous tissue is a late result of this process. (BBB)

12980 BASAL AND SQUAMOUS CELL CARCINOMA OF THE FACE. Larson, D. L.; Lewis, S. R. (Univ. of Texas, Galveston). Tex. Rep. Biol. Med., 24: 403-17(Fall 1966).

The causation of cancer of the facial skin by various types of radiation is discussed as well as the use of radiotherapy to eradicate such cancers. Prevention of injury to normal tissues in radiotherapy and the nature of such complications are also considered. Exposure of skin to large doses of uv or ionizing radiation may result in malignant changes. If x radiation is used, it is advisable to employ a long fractionation technique. This produces less interference with the poorer blood supply over cartilage and with subsequent healing. Utilization of lead shields to protect surrounding tissue also benefits in decreasing complications of radiation. Irradiation as the treatment for carcinoma of the external ear may be highly effective, but as in the nose, the cartilage of the ear is covered with a thin layer of soft tissue; thus, chondritis may frequently follow radiotherapy. (TSS)

12981 EVOLUTION OF SARCOMA 37 IN CF1 RATS. BIOLOGICAL ASPECTS OF THE SPONTANEOUS CURE OF TUMORS STUDIED AFTER IRRADIATION AND ADMINISTRATION OF IMMUNE SERUM. Clode, William H. (Instituto Portugues de Oncologia de Francisco Gentil, Lisbon). Arq. Patol. (Lisbon), 37: 109-26(Dec. 1965). (In Portuguese).

An experimental tumor system was used to evaluate the effect of 400 R whole-body x-irradiation on tumor-cell survival and subsequent immunity to the tumor. Transplantation of sarcoma 37 in CF_1 mice was studied; 99% of the 809 mice inoculated developed the tumor. Development of the tumor in relation to the number of cells inoculated was studied, and it was observed that the initial growth of the tumor, its spontaneous regression, and the mean survival time of mice were related to the number of cells implanted. In the mice that were cured spontaneously, the tumor showed great resistance against reimplantation, even after 5 reinoculations. In mice whole-body irradiated before the implantation of S-37, the tumor grew faster, the animals had a shorter survival time, and spontaneous regressions were fewer than in the control group. The irradiation of immune mice, reimplanted with S-37, did not alter the animals' reaction against the tumor. It was not possible to transmit passively via the serum of immune mice any factor which showed an influence on the tumor growth. (BBB)

12982 RADIATION EFFECTS IN MAN. New Engl. J. Med., 274: 1146-7(May 19, 1966).

Recent studies of human populations exposed to ionizing radiation are briefly reviewed. This includes a survey of the leukemia experience of the survivors of the atomic explosions at Hiroshima and Nagasaki. During 1960-64, almost 20 years after the bombing, persons who had been within 1500 m of the hypocenters of the explosions were still manifesting a leukemia rate of six or seven distances. A peak incidence of leukemia, evident in acute and in chronic myelocytic forms, occurred five to eight years after exposure, but a second peak, evident only for acute cases, appeared 13 to 14 years after exposure. In the first ten years after exposure 54% of the cases were acute; 10 to 19 years after exposure 84% were acute. A high incidence and short latency period for chronic myelocytic leukemia is evident in persons under 30 years of age at the time of exposure. Continued follow-up examination of patients irradiated for ankylosing spondylitis confirms the high incidence of leukemia in this group. New observations show higher than expected rates for cancer of the pharynx, stomach, pancreas, lung, lymph nodes, and other heavily irradiated sites. Other recent reports dealing with other specific cancer sites (for example, the breast and the anal and lower genital regions) support the concept that radiation may induce neoplasia in most, if not all, human tissues. Findings relevant to the controversial life-shortening effect of radiation are also surveyed. The higher mortality of the radiologists is evident in many causes of death, including cancer, renocardiovascular disease, and all other causes combined. (BBB)

12983 TACHISTOSCOPE FOR X RAYS. Garcia, John (Massachusetts General Hospital, Boston); Schofield, J. R.; Oper, Don. Amer. J. Psychol., 79: 318-20(June 1966).

An apparatus is described which was designed to deliver extremely brief x-ray doses to serve as stimuli or signals during behavioral tests with rats. Since the purpose of these tests was to determine whether rats could detect radiation via sensory receptor as an immediate physiological effect of the exposure, the major technical difficulty lies in necessity to expose the animal without visual or auditory cues which could inadvertently elicit a false response. This apparatus solves this problem and is inexpensive, is portable, and does not require modification of the x-ray machine. Responses to 20 mR delivered in 0.1 sec demonstrated use of this device. The apparatus consists of 3 components: (A) A moveable shutter constructed of plywood and ⅛ in. lead, suspended by nylon cords from the ceiling so that it shuts off the beam when it hangs at rest. (B) The second component, a tachistoscope or circular shutter, makes it possible to time the exposure much more precisely than with the suspended shutter alone. (C) The third component is a device to detect radiation, and consists of a photocell, a dc bridge circuit, and an amplifier. The circular shutter is rotated without interruption at a constant speed during the entire experimental session to eliminate off-on sounds. For brief exposures a speed of 20 rpm allows ample time to open and close the suspended shutter during one revolution, thus allowing a single exposure through the slot in the wheel. For further precautions to eliminate stimulus artifacts, the animals were tested in an acoustically and electrically shielded compartment equipped with a speaker which emitted a white noise masking sound. Thirsty animals were trained to enter a narrow tunnel to obtain water, thus confining themselves to the area of the x-ray beam. Lapping at the water spout was recorded electronically with a drinkometer. A final precaution was a sham-irradiation test, in which the copper filter in the x-ray machine was replaced with a lead plate. These conditions should reveal if a stimulus artifact is operating as a signal to produce false responses. (BBB)

12984 THE ULTRASTRUCTURE OF THE SUPERIOR CERVICAL GANGLION OF THE RAT. III. THE EFFECTS OF X RAYS. Forssmann, W. G.; Tinguely, H.; Posternak, J. M.; Rouiller, Ch. (Ecole de Medicine, Geneva). Z Zellforsch. Mikroscop. Anat., 72: 325-43(1966). (In German).

Electron microscopy was used to follow fine structural changes in this isolated neural element after high-dosage irradiation. The superior cervical sympathetic ganglion of the rat, maintained in vitro in Krebs' solution, retains its ability to transmit nervous impulses for more than 48 hr. Exposure to x rays at a dose of ~153,000 rad, given over 30 min, curtailed the duration of electrophysiological function of the ganglion. It also rendered the preparation more susceptible to changes in the chemical composition of Krebs' solution. As seen electron microscopically, irradiation produced early and severe lesions of the satellite cells. The changes within the neuron occurred later and affected the nucleus, the lysosomes, Nissl substance, and, to a lesser degree, mitochondria. Cell processes, dendrites, and axons showed the greatest resistance to irradiation. (BBB)

12985 ON THE EFFECT OF SMALL DOSES OF IONIZING RADIATION (GAMMA RADIATION AND X RAYS) ON THE HUMAN EYE. (REVIEW OF THE LITERATURE). Vishnevskii, N. A. Vestn. Oftal'mol., 77: 67-74(May-June 1964). (In Russian).

Local effects of ionizing radiation on individual eye tissues and the influence on the eye as a whole were reviewed. A total of 87 references were given, most of which were from the Russian literature. Many authors have noted a favorable therapeutic effect in benign diseases with local irradiation in doses of 20 to 40 R and even up to 100 R. For acute and chronic uveitis doses of 60 to 100 R per session may be used over a 10-week period. However, such doses may aggravate some inflammatory diseases of the eye. Some authors have used doses as high as 10,000 R in ocular therapy. Changes caused by aging should be considered when studying radiation effects on the eye. (TSS)

12986 MAST CELLS AND CANCER OF THE CERVIX. Graham, Ruth M.; Graham, John B. (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 123: 2-9(July 1966).

A correlation of radiation response with the incidence of mast cells in cervical tissue was established in this study of 140 invasive carcinomas of the cervix. The study is an extension of an earlier one using a prognostic method of radiation response, as determined by the numbers of benign epithelial cells in the vaginal

smear that show radiation effect during treatment. If many benign epithelial cells show radiation response, the prognosis is thought to be good. If few show the response, it is poor. Few patients with poor radiation response were available for analysis. Patients were chosen who would, from previous experience, have a poor cytologic radiation response and surgical treatment was used rather than irradiation. Though there was a difference between the poor and good radiation response groups, the difference between many and few mast cells was far more significant and striking. The presence of many mast cells was more critical for survival than good radiation response. Thus, 83% of patients with a good radiation response showed many cervical mast cells compared with 51% showing only a few mast cells. It was noted earlier that local irradiation promptly increased the mast cell number in the peritoneal cavity of mice, and it is well known that ionizing radiation produces an increase in mast cell numbers. Dogs given total-body radiation have a greatly increased clotting time and incoagulable blood at death, presumably from heparin released from mast cells. It is concluded that their increase by ionizing radiation in favorable patients supports the impression that radiation exerts its beneficial effect by stimulating the defense mechanism. (BBB)

12987 PERSISTENT RADIATION CHANGES IN VAGINAL SMEARS AND THEIR MEANING FOR THE PROGNOSIS OF SQUAMOUS CELL CARCINOMA OF THE CERVIX. Ceelen, Guenther H. (Ohio State Univ., Columbus). Acta Cytol., 10: 350-2(Sept.-Oct. 1966).

Attempts were made to delineate the cytological changes which constitute the radiation reaction and to determine if it has any significance for the survival of the patient. The study included 136 patients with squamous cell carcinoma of the cervix, Stages I–III, treated by internal and external radiation who had shown a strong, persistent radiation reaction 2 yr after therapy was begun and thereafter. The amount and type of radiation used varied. Radium or ^{60}Co was used for internal therapy and was followed by external irradiation about 6 weeks later. The follow-up results of these patients were compared with those of 114 patients who did not show persistent chronic radiation changes. Criteria for chronic radiation changes were those described by Graham (increase in size of basal and parabasal cells with maintenance of their natural nuclear/cytoplasmatic ratio, multinucleation, bizarre nuclear forms with focal hyperchromasia, cytoplasmatic polychromasia, acidophilia, and vacuolation). The results showed that such persistent changes accompany a better prognosis for the patient as compared with patients without them after 2 yr. Care must be taken not to misinterpret bizarre radiation changes as recurrent carcinoma. The long duration of radiation changes in some patients pointed towards a local rather than to a generalized causative mechanism. Additional support is offered for the occasional occurrence of carcinoma in situ after radiation treatment for invasive squamous cell carcinoma. (BBB)

12988 SARCOMA OF THE UTERUS. Boutselis, J. G.; Ullery, J. C. (Ohio State Univ., Columbus). Obstet. Gynecol., 20: 23-35(July 1962).

The possible radiation-induced occurrence of uterine sarcoma in patients previously irradiated for other uterine malignancies was evaluated in a large number of patients. Thirty-six cases of uterine sarcoma of a total 28,066 gynecologic hospital admissions between 1940 and 1959 inclusive are reviewed. The sarcomas constituted 2.0% of all uterine malignancies observed during this period. The literature is reviewed concerning the relation of sarcoma to previous irradiation. It is evident that serious consideration of irradiation as an etiologic factor in subsequent development of uterine sarcoma has been entertained by some investigators. In 1950 a report mentions 3 patients (8.3%) who had received intracavitary radiation for benign uterine bleeding 6, 10, and 11 yr prior to the development of sarcoma. In 1951 it was reported that 4 patients (16%) had received intracavitary radium (1200–2400 mg-hr) 11, 13, 14, and 15 yr before the development of sarcoma. Another report refers to 4 cases of sarcoma developing 4 to 21 years after radiation therapy. A 4th comprehensive study of the subject pointed convincingly to irradiation as an etiologic factor. In the present series, 6 sarcomas were encountered subsequent to irradiation for benign uterine bleeding (5 cases) and cervical cancer (1 case). Two were excluded, however, because the time interval between irradiation and the diagnosis of sarcoma was slightly less than 6 months. Details of the remaining 4 cases are given. (BBB)

12989 RADIATION INDUCTION OF EPITHELIAL CYSTS. Jones, D. C.; Castanera, T. J.; Kimeldorf, D. J.; Rosen, V. J. (Naval Radiological Defense Lab., San Francisco). J. Invest. Dermatol., 47: 110-14(1966).

The distribution of grossly observable skin cysts among male Sprague-Dawley rats, either sham-irradiated or exposed (whole-body) to doses of x rays or neutrons in the sublethal or lethal (30-day) range, is described. The doses of 430 or 680 rad of x rays or of 230 or 320 rad of fast neutrons were given at 101 days of age. Survival during the first month after exposure was 100% for the lower doses, and after the higher doses of x rays and neutrons, survival (30-day) was 54% and 86%, respectively. Animals were examined for the presence of skin cysts at monthly intervals throughout life. Cysts varied from 2 mm to a few cms in dia. Most (89%) were histologically identified as epithelial cysts, enclosing a mass of laminated cornified material. The remainder were either true sebaceous cysts (6%) or were of unidentifiable origin (5%). The over-all incidence of animals with cysts was significantly increased by both doses of x rays and by the higher dose of neutrons. In all 4 irradiated groups, cysts appeared earlier than in controls. In control animals, the age-specific cyst rate began to rise appreciably at about 18 months of age, while for irradiated groups it began to rise 5 to 6 months earlier. The results agree with the concept of cyst formation through the differentiation of the equipotential cells of the epidermis and with the categorization of epithelial cysts at benign neoplasms. (BBB)

12990 A MICROLYMPHANGIOGRAPHIC STUDY OF THE REGENERATION OF LYMPH VESSELS IN RABBIT EAR AFTER PRE-OPERATIVE ROENTGEN IRRADIATION: A PRELIMINARY REPORT. Kjellman, Thord (Laenslasarettet, Mariestad, Sweden). Acta Chir. Scand., 124: 87-8(1962).

The advisability of using pre-operative irradiation in treatment of cancer of the breast is controversial, and there is no agreement with respect to the optimal time interval between pre-operative irradiation and operation. The cause of the edema that frequently appears in the arm after treatment is variously considered to be a result of the operative procedure or of the irradiation. To elucidate this problem, the effect of pre-operative x irradiation on regeneration of the lymph vessels was studied in rabbit ears by microangiographic methods. Four groups were studied, with different radiation intensities and preoperative irradiation intervals. In series 1 and 2 the last pre-operative irradiation was made 8 days before the operation, and in series 3 and 4 it was made 32 days before operation. In series 1 and 3, the total surface dose of x radiation on each ear was 4000 R, i.e., 4 days × 1000 R; and in series 2 and 4, it was 2000 R, i.e., 4 days × 500 R. The only factor considered was whether regeneration of the lymph vessels was evident on the x-ray film on the 8th day after operation, this time being chosen because regeneration in almost all cases was apparent on the 8th day. In the control ears, 33 cases of regeneration of the lymph vessels was found out of 36 animals. In the pre-operatively irradiated rabbit ears, regeneration of the lymph vessels was apparent in 32 cases out of 36 on the 8th day after operation. It was apparent that irradiated ears showed a lymph passage as early as the nonirradiated control ears of the same animals. Pre-operative irradiation in large doses, however, enhanced necrosis and impaired the formation of lymph vessels and increased the serum leakage owing to the unclosed lymph vessel. (BBB)

12991 PREVIOUS DIAGNOSTIC IRRADIATION IN 5 CASES OF CHRONIC MYELOID LEUKEMIA IN CHRONIC TUBERCULOUS PATIENTS. Rousso, C.; Maurice, P. A.; Alberto, P. (Univ., Geneva). Schweiz. Med. Wochensch., 96: 1218-19(Sept. 17, 1966). (In French).

Five case histories are presented for patients in whom it is believed leukemia may have been induced by repeated exposure to chest x rays. Diagnosis of pulmonary tuberculosis had preceded by 6 to 21 yr the development of chronic myeloid leukemia. All of the patients had been subjected to repeated thoracic irradiation for radiography and in some cases fluoroscopy. Three of the 5 patients had received a large cumulative dose of radiation. The evidence for leukemogenic action of ionizing radiation is reviewed, and it is concluded that these cases comply with the criteria for radioinduced leukemia. The optimal induction period of 5 to 7 yr represents the average latent period for these cases. Warnings are given regarding the excessive use of radiography in following tuberculosis cases and of avoiding entirely the use of fluoroscopy, which gave a dose rate in the patients described here of ca 13.5 R/min. No data for total dose received by these patients are available. (BBB)

12992 CURRENT PROBLEMS OF PATHOLOGIC CONDITIONS CAUSED BY LIGHT IN DERMATOLOGY. Wiskemann, A. (Univ., Hamburg). Hautarzt, 16: 385-8(Sept. 1965). (In German).

The author reviews and discusses numerous aspects of skin changes observed after chronic exposure to uv light. These include factors, such as age, skin thickness, melanin content, amount of light, and quality of light. Exposure to uv light of 300 to 330 nm is most important for genesis of actinic cancer. For uv erythema the most important wavelength is 307.5 nm. In humans the fre-

quency of skin cancer is related to the conditions of radiation, vocation, skin color, and clothing worn. The consequences of chronic uv light exposure on melanocytes and the cutis are reviewed. Abnormal patterns in exposed persons are discussed. Light dermatoses are discussed in terms of photosensitization in contrast to photoallergy. These include, among others, porphyria cutanea tarda, erythropoietic protoporphyria, pellagra, polymorphic dermatoses, and light urticaria. Biochemical factors involved in development of light dermatoses are discussed. References cited, 88. (BBB)

12993 INJURIES RELATED TO RADIATION TREATMENT OF CARCINOMA OF THE CERVIX AND COMPLICATIONS OF SUPPLEMENTAL SURGERY. Hurteau, Gilles D. (Univ. of Ottawa); Morris, John McLean; Chang, Chu H. Amer. J. Obstet. Gynecol., 95: 696-705(July 1, 1966).

Complications in 300 cases of cervical cancer treated by radiation therapy, employing a new flexible rubber applicator, are analyzed. There were 15 injuries (5%) attributed to radiation alone, 9 injuries (3%) attributed to radiation and a contributing factor (e.g., flare-up of salpingitis), and 29 injuries (9.7%) attributed to radiation and surgery. When graded on the basis of severity, two thirds of the radiation-alone injuries were transient, whereas when surgery was added, two thirds of the injuries were permanent or required surgical intervention. As only 101 cases in the series underwent operation, the injury rate in the operation and radiation series (28.8%) is 3 times greater than that of patients receiving radiation only (7.5 to 11.9%). There seems to be little evidence to support programs of therapy in cervical cancer involving massive pelvic radiation or routine combinations of intensive radiation and radical surgery. Disregard of limits of tolerance of pelvic tissue may result in excessive injury rates and radiation or surgical injuries may ultimately prove more of a burden than the disease itself. (BBB)

12994 SUBCUTANEOUS CARCINOGENESIS BY ^{14}C- AND ^{3}H-LABELED POLYMETHYLMETACRYLATE FILMS. Tomatis, Lorenzo (Chicago Medical School). Tumori, 52: 165-72(1966).

Implantation of ^{14}C- and ^{3}H-labeled polymethylmetacrylate films was used in mice to study their possible degradation and the effect of low doses of radioactivity on the induction of sarcomas. The films, with specific activity of 4810 and 256,000 cpm/mg, were inserted subcutaneously in Swiss mice in amounts ranging from 32 to 200 mg. The 128-mg (12 mm^2) implant size appeared to be the optimal tumor-inducing size, resulting in a 26% incidence of tumors. The smaller sizes resulted in a 6.6% incidence of tumors. Labeling of the implants with ^{14}C or ^{3}H had no influence on tumor-producing capacity. Only in one group of mice, which were implanted with a 200 mg ^{14}C film, was the incidence notably higher than in the corresponding group implanted with a nonlabeled film, namely 50% against 26%. Survival rates as well as the incidence of tumors other than sarcomas did not show any significant difference between the various sizes and isotopes used. Thus, no consistent radiocarcinogenic effect was seen. In the urine from the mice implanted with ^{14}C-labeled film a consistent rise of radioactivity occurred between the 2nd and the 4th week and continued until the 8th week when the maximum value was reached. In the 9th week there was a sudden drop. In the urine from mice implanted with ^{3}H-labeled film, a rise of the count values was observed between the 4th and the 7th week. From the 8th week the values fell considerably, but remained higher than control values. (BBB)

12995 EFFECT OF COLCHICINE ON THE HEMOLYSIN RESPONSE IN UNIRRADIATED AND IRRADIATED RABBITS. Jaroslow, Bernard N.; Taliaferro, William H. (Argonne National Lab., Ill.). J. Infect. Dis., 116: 139-50(Apr. 1966).

Treatment of rabbits varied with respect to the amount of x rays (25 to 700 R), antigen ($10^{8.2}$ to $10^{10.2}$ sheep red cells per kg rabbit), and colchicine (0.067 to 1.8 mg per kg rabbit) and also with respect to the time of injecting colchicine (1 day before to 6 days after the injection of antigen). In testing radiation-induced effects the antigen and colchicine were always injected 1 day after irradiation. Results indicated that colchicine in progressively increasing amounts stimulated the production of more hemolysin, as gauged by peak titer, at higher rates in both irradiated and unirradiated groups as compared to controls, but the latent period was not modified. The largest dose of colchicine was decreasingly active as the x-ray dose was increased but was strikingly more active as the antigen dose was increased in irradiated (400-R) and unirradiated groups. In addition, the drug was most active when injected either during a 12-hr period in unirradiated rabbits extending from 12 hr before to simultaneous injection with the antigen, or during a 36-hr period in irradiated rabbits (400 R the day before the injection of antigen) extending from 12 hr before to 24 hr after antigen injection. It was progressively less active in both groups when injected 3 days after the injection of antigen and was essentially inactive when injected 6 days afterwards. The importance of nucleic acids and their degradation products, whether introduced directly or indirectly through the activity of a cytotoxic agent such as colchicine, in the induction of antibody synthesis is emphasized. It is suggested that various agents restore or enhance antibody formation by supplying extra amounts of nucleic acid degradation products to cells unable to synthesize the appropriate enzymes for nucleic acid synthesis, as in irradiated animals, or by inducing premature nucleic acid synthesis in uninjured cells, as in unirradiated animals. Such cells are then susceptible to stimulation by antigen and can subsequently initiate the processes leading to antibody synthesis. (BBB)

12996 RADIATION INJURY BY UNPROFESSIONAL NEGLIGENCE OF MEDICAL CAUTION AND PRINCIPLES OF COMPENSATION TO BE PAID. Schmeicher, R. Deut. Med. Wochenschr., 91: 1058-9(June 3, 1966). (In German).

Compensation for radiation injuries are based on not only monetary considerations, but also on the actual injuries done to the injured person. The hazards of x irradiation demand a high degree of consideration from the physician, but at the same time the physician cannot act with the safety of a precision instrument and may overlook certain things, especially during a difficult and lengthy use of x-ray apparatus with a portion of the body that is relatively inaccessible. The psychic injury to the patient that accompanies physical irradiation injuries must be kept in mind during legal considerations. The fear of those injured by irradiation that a carcinoma may result from overexposure should not be overevaluated by a court of law. Payment of compensation over long periods for irradiation injuries should be limited in time and reconsidered in later years to ascertain justification for their continuance. (BBB)

12997 SIMPLIFIED PHOTOPATCH TESTING. Epstein, Stephan (Univ. of Wisconsin, Madison). Arch. Dermatol., 93: 216-20(Feb. 1966).

A method is described for testing uv skin sensitivity (photoallergic contact dermatitis). All cases of photoallergic contact dermatitis have been reproducible by longwave uv light of a wavelength of 3200 Å. Therefore, this is the ideal radiation for photopatch tests. These rays do not burn normal skin, yet are able to reproduce photocontact dermatitis. By using an appropriate filter, e.g., window glass, any hot quartz mercury lamp can be converted into an adequate source of longwave uv light since the window glass filter eliminates shortwave sunburn radiation below 3200 Å. In the technique described patch tests are applied with the suspected photosensitizers in duplicate on symmetrical areas on the patient's back, arms, or legs. The patches are removed after 24 hr. After the patches are removed, one set is irradiated with longwave uv light. The other set, protected against light, serves as a control. With the use of unfiltered uv light for photopatch tests, determining the proper exposure time requires for each patient a determination of his minimal erythema dose (MED). The determination of the exposure time for filtered longwave uv light can be simplified by using as a measuring unit the MED equivalent (MED equiv). A MED equiv for a hot mercury arc lamp is defined as that amount of longwave uv light contained in a MED after it has passed through a filter which eliminates the radiation below 3200 Å. The determination of the MED equiv for a given lamp is based on the average MED for that particular source of light and does not require the determination of the individual MED of the patient to be phototested. The average MED of a lamp is determined by measuring the MED of four normal persons who are not light-sensitive and using the average. Twenty MED equiv of longwave uv is adequate in almost all cases of photoallergic contact dermatitis. (BBB)

12998 SOME EFFECTS OF LASER RADIATION ON THE SKIN OF THE SYRIAN HAMSTER. Fine, S. (Northeastern Univ., Boston); Klein, E.; Scott, R.; Seed, R.; Roy, A. Life Sci., 2: 30-5(Jan. 1963).

Hamsters were irradiated with a single laser pulse of 20 J focussed onto one or more areas of the surface of the anterior abdominal wall. The immediate effects resembled those of a 2nd degree thermal burn extending over a circular area of 3 to 8 mm in diameter with a mild erythematous areola 1 to 2 mm in width. In the cheek pouch extruded and exposed to irradiation, the immediate reaction was similar to a moderately severe burn. All animals in the first group recovered completely from the immediate effects of exposure. Appearance of the lesions in the skin on the 5th day postirradiation suggested a more severe reaction in the lighter colored than darker regions. Microscopic appearance indicated coagulation necrosis, leukocytic infiltration separating necrotic areas from viable tissue, and epithelialization originating from the margin of the lesion. In animals in the second group exposed to 50 J, the immediate and subsequent effects were similar to those observed in the first group. One animal died within 5 hrs

of irradiation. At autopsy, a moderately severe reaction consisting of hemorrhage and edema was observed, extending through the anterior abdominal wall onto the peritoneal surface without apparent discontinuity of the peritoneum. Subjacent areas of the stomach and intestine showed distension, serosal hemorrhages, and edema. Successive irradiation of an area with up to 3 pulses caused lesions with characteristics similar to those of lesions induced by single pulses. However, increase in the intensity of lasered radiation produced more severe and more penetrating lesions. (BBB)

12999 TOLERANCES OF SEVERAL MARINE SPECIES TO ^{60}Co IRRADIATION. White, John C. Jr. (Fish and Wildlife Service, Bureau of Commercial Fisheries, Beaufort, N. C.); Angelovic, Joseph W. Chesapeake Sci., 7: No. 1, 36-9(Mar. 1966).

Mean lethal dose-time curves are used to describe the radiation tolerances of 6 species of marine teleosts and 2 species of marine invertebrates. These curves describe radiation tolerances better than the commonly used LD_{50} (30 day) values since they show changes in LD_{50}'s with increasing time after irradiation. Table. 2 figures. 8 references. (auth)

13000 WEIGHING THE RISK OF FETAL DAMAGE: X-RAYS IN PREGNANCY. Raventos, Antolin (Univ. of Pennsylvania, Philadelphia). Amer. J. Nursing, 66: 1308-11(June 1966).

A description of the effects of ionizing radiation on the fetus is given. The risk for any particular type of fetal damage depends greatly on the stage of development when the radiation exposure occurs. In the first three weeks after conception the embryo consists of relatively few cells. If radiation injury occurs then, it is usually lethal. In the period from the third to the sixth week of pregnancy, the major organ systems are being formed and are most susceptible to irradiation. The highest incidence of gross abnormalities results from exposure during this period. After six weeks when the major structures have been formed, radiation is not likely to produce gross physical anomalies; however, certain defects in body function may be produced by exposure in this interval. If exposure has occurred in the early period and if the dose was so high that an abnormal baby seemed almost certain to result, there would be good reason to consider a therapeutic abortion. Usually the dose delivered to the fetus from a properly performed modern diagnostic x-ray examination is very low, even if several studies involving the pelvis are done. Exposure of pregnant women to radiation should be avoided whenever the risk might be greater than the benefits to be gained. It is important to choose the early part of the menstrual cycle for elective x-ray examinations, but this policy must be applied judiciously and never made into an inflexible rule. (TCO)

13001 METHOD TO DETERMINE LASER WAVELENGTH ABSORPTION CAPABILITIES OF EXPERIMENTAL MALIGNANT TUMORS. Minton, John Peter (National Cancer Inst., Bethesda, Md.). Life Sci., 3: 1007-10(Sept. 1964).

Since the laser energy absorbed in various tumors is dependent on the pigmentation of the tumor, determination of the optical density of various tumors at the wavelengths of high-energy laser equipment is necessary in predicting which laser source would be most effective for tumor destruction. Techniques are illustrated to show how the absorption spectrum of various tumors may be determined and compared. Two tumor systems were studied by the same technique: CDBA/2F_1 hybrid mice with a 3-week-old subcutaneous implant of Cloudman S-91 melanoma and C57BL/6jN mice with a similarly implanted 3-week-old Lewis T241 sarcoma. Absorption spectra for the 2 diluted tumor cell homogenates are shown. The percent energy absorbed at the ruby laser wavelength (6943 Å) in either tumor system was ca twice the per cent energy absorbed at the neodymium laser wavelength (10,600 Å). The lightly pigmented Lewis T241 sarcoma absorbed a proportionally lower percent of the energy at any given laser wavelength. Detectable differences in percent energy absorbed existed in the near ir and ir range. The wavelength absorption curves indicated that high-energy laser irradiation of a shorter wavelength would be even more effective for tumor destruction than the laser sources currently available. These experiments indicated that lightly pigmented tumors generally require a larger amount of laser energy for permanent destruction than do heavily pigmented tumors of a similar size. (BBB)

13002 THERMONUCLEAR WEAPONS AND THE PHYSICIAN. Jobe, Charles L. (Veterans Administration Hospital, Oklahoma City, Okla.). J. Oklahoma State Med. Ass., 59: 22-7(Jan. 1966).

Physical and biological effects of nuclear explosions are reviewed preliminary to a discussion of medical treatment of casualties of blast, heat, immediate radiation, and fallout from thermonuclear detonations. Radiation hazards may produce 90% of the casualties from a thermonuclear blast but are derived from only 15% of the total energy of the detonation. The injuries produced by ionizing irradiation are described. Descriptions of pathology are based on Japanese bomb casualties, Marshall Islanders injured as a result of unexpected wind changes at Bikini in 1954, and on lab and industrial accidents. Various forms of injury occur dependent on the dose received. Only γ radiation is considered in the hematopoietic, gastrointestinal, and central nervous system forms of radiation sickness. Radiosensitivity of various cell types governs the response. Hematopoietic disease is most pronounced in those receiving about 300 R, although it may occur with any dose from 100 to 1000 R. The various stages are outlined. Gastrointestinal and cerebral symptoms and their underlying pathology are also discussed, as are reactions to and protection from fallout radiation. (BBB)

13003 SUBJECT OF POSTIRRADIATION PROCTITIS AND RECTAL RECURRENCES IN PATIENTS WITH GYNECOLOGIC NEOPLASM. Bellone, F.; Stringa, L.; Guglielminetti, G. (Univ., Genoa). Minerva Ginecol., 16: 789-99(Oct. 15, 1964). (In Italian).

Literature relating to the incidence of rectal injuries resulting from radiotherapy is reviewed, and the authors' ten-yr series of 754 cases of genital cancer was surveyed for the occurrence of such complications. This survey revealed 16 patients who, although cured of cancer, developed radiation-induced proctitis years after radiotherapy. This incidence of 2.12% is lower than in most reports in the literature; in 10 such reports it occurred in 1.3, 3.4, 4.0, 4.2, 8.2, 10.3, 11, 21, 28.8, and 31.3% of cases irradiated. The latent period in these 16 patients between irradiation and first appearance of symptoms varied from one month to three yr; 19% of the cases occurred relatively early and 81% were classified as late effects. In most cases the rectosigmoid disorders were associated with combined radium-telecobalt therapy. Proctorrhagia was the presenting symptom in most cases, with pain and diarrhea as less frequent or accompanying symptoms. Most cases showed Grade II postirradiation reactions proctoscopically, as classified by Kottmeier. Examination revealed erythematous, congested, de-epithelized rectal musoca. Stenosis was present in one-fourth of the cases, caused by an annular fibrosis. (BBB)

13004 LOCAL IRRADIATION OF LYMPH NODES IN RATS: MORPHOLOGICAL AND FUNCTIONAL ALTERATIONS WITH RELATION TO CANCER THERAPY. Engeset, Arnfinn (Norsk Hydro's Inst. for Cancer Research, Oslo). Progr. Exp. Tumor Res., 8: 225-70(1966).

Radiation damage to the lymph nodes and their vessels was studied in rats after local x irradiation of the right popliteal node or of the renal nodes on the right side. The standard single dose was 3000 R, measured in the lymph nodes. Animals were examined at various intervals from 12 hours to 88 weeks after irradiation. A decrease of lymphocytes was seen 12 hr after irradiation, followed during the first days by an increase toward normal values, and then again a slow and permanent decrease. There was a slow and progressive induration of connective tissue and, later, some sinuses were destroyed. The weight of the irradiated nodes decreased. Lymphangiography showed that the course of the vessels was unaltered 6 to 9 months after irradiation. One year after irradiation the contrast medium bypassed the irradiated nodes. The barrier function of the lymph nodes was reduced after irradiation for both human erythrocytes (dia 7 μ) and toad erythrocytes (15 μ), but not for charcoal particles (60 μ), injected into the afferent lymphatics. The failure of the barrier function was demonstrable two weeks after irradiation and became more marked with time. Intralymphatic injection of Walker carcinoma cells caudal to the irradiated nodes led to more pulmonary metastases in the irradiated animals than in the controls. An inflammatory reaction induced with diphtheria-tetanus-pertussis vaccine spread more readily through the irradiated nodes. In animals irradiated with 10×600 R at daily intervals, alterations similar to those after irradiation with 3000 R were observed. In animals irradiated with 5×600 R, the alterations were less pronounced. It appears that clinical irradiation of lymph nodes draining a cancer area should be performed only to destroy already existing metastases. (BBB)

13005 THE EFFECT OF X-IRRADIATION ON THE SURVIVAL OF LIPONYSSUS BACOTI AND ON ITS SUSCEPTIBILITY TO INFECTION WITH LITOMOSODOIDES CARINII. Quraishi, M. A. H.; Kershaw, W. E.; Jayson, G. G. (Univ. of Liverpool). Ann. Trop. Med. Parasitol., 60: 57-62(1966).

The effect of x irradiation on the survival of the tropical rat mite L. bacoti was studied in 13-day-old female mites exposed in batches of 50 to doses of from 50,000 to 150,000 rad. Results showed that irradiation diminished survival in direct proportion to the dose. By 15 days the mortality of the mites irradiated before feeding was nearly 5 times that of the controls. The intensity of infection with L. carinii was higher in the few mites

that survived after irradiation than in the surviving controls; but, when the intensity of infection was expressed as a fraction of the original mite population, irradiation of the mites before they acquired their infection reduced the parasite population that, after being taken up, became infective to about half that of the unirradiated mites. In mites irradiated after feeding, mortality was increased to 4 times the normal rate in 15 days, an effect slightly less great then that following irradiation before feeding. The intensity of infection in the few mites that survived after irradiation was very much lower (a third or a quarter) than that in the surviving control mites. When the intensity was expressed as a fraction of the original mite population, irradiation of the mites after they had acquired their infection (and therefore involving irradiation of the developing parasites) reduced the parasite population that survived to become infective to less than one tenth that of the unirradiated controls. The apparent increase in the intensity of infection with L. carinii is due to selection by irradiation. (TSS)

13006 THE ACTION OF X RAYS ON THE DIFFERENTIATION AND DEVELOPMENT OF NUCLEOLAR STRUCTURES IN RELATION TO CELL DIVISION. Herich, R. (Comenius Univ., Bratislava). Flora, 155: 505-10(July 15, 1965).

Studies of influence of x radiation on the cell have shown that radiation influences not only chromosomes but also the differentiation and development of various nucleolar structures. The experiments described were carried out on hemp (Cannabis sativa) seedlings, 1 cm long. They were irradiated by doses of 500, 5000, and 10,000 R; 24 hr after irradiation the root tips were fixed and stained for nucleolar structures with Heidenhains' iron hematoxylin. In the nucleolus 3 structures, designated as structures A, B, and C, could be clearly observed. Most of the volume of young, recently differentiated nucleoli is occupied by structure A. In it, in the form of a small chromosome or threadlike structure, B is located. This structure is not homogenous but consists of one or several heterogenous segments, designated as segments D. The volume of structure B increases during interphase. Near segments D, structure C is differentiated either into a single or multiple spherical structure(s). A different morphological development of the nucleolus could be observed after irradiation of root tips, especially when high doses were used. Irradiation causes a successive inhibition of the growth of structures B and C, while an increased growth of structure A takes place. At 24 hr after irradiation of seedlings by a dose of 10,000 R, cell divisions are completed and nucleoli are differentiated. The growth of structure B is inhibited. The differentiation of structure C is slowed down and if it is differentiated at all, the differentiation is very slight. Most of the volume of the nucleolus is occupied by structure A. The effect of radiation upon nucleolar structures is manifested only after cell division, during the differentiation of nucleolus. In nucleoli of nondividing cells, no substantial changes in the morphological development of nucleolar structures were observed after irradiation. A close relation between the differentiation of nucleolar structures and cell division was observed. It is concluded that even low doses of radiation can affect the differentiation and development of the nucleolar structures, resulting in a partial inhibition of the differentiation of the various structures. (BBB)

13007 FUNCTION CHANGES SECONDARY TO LOCAL IRRADIATION IN KIDNEYS DAMAGED BY ISCHEMIA. Gup, A. K.; Schlegel, J. U.; Caldwell, T.; Schlosser, J. (Tulane Univ., New Orleans). J. Urol., 96: 16-19(July 1966).

The observation that small doses of local irradiation may modify the graft rejection phenomenon prompted a study of the possible beneficial effect of similar irradiation on renal injury from ischemia alone. The renal arteries of dogs were clamped for 75 min after which the kidneys were explanted subcutaneously. One kidney was then irradiated at 200 rad/day for 3 days. Twenty-four hr after the last dose of irradiation, renal function tests were done. The irradiated kidney excreted more urine and had greater radiohippuran clearance than the nonirradiated kidney in 23 of the 24 dogs. In 8 other dogs the irradiated kidney excreted more urine and in all but one of these had greater radiohippuran clearance than the nonirradiated kidneys 31 days after renal ischemia. No similar consistent pattern was observed in the urinary osmolality and sodium for the irradiated and nonirradiated kidneys. Serial renograms also showed that the irradiated kidney had better function than the nonirradiated kidney, but returned to normal 10 to 14 days after operation. At necropsy, no significant difference was observed in weight or gross appearance of the irradiated and nonirradiated kidneys of any of the dogs. The ischemic histologic changes were qualitatively the same; however, their quantity seemed to be less in the irradiated kidney. No explanation is offered for this beneficial effect of local irradiation. (BBB)

13008 LASER AND THE LABYRINTH: SOME PRELIMINARY EXPERIMENTS ON PIGEONS. Stahle, J.; Hoegberg, L. (Uppsala Univ.). Acta Otolaryngol., 60: 367-74(Oct. 1965).

A description is given of histologic changes occurring when the inner ears of pigeons were irradiated by a Q-switched ruby laser with an output pulse energy of about 0.3 J. The laser beam penetrated up to 1 mm of bone, causing burning in a localized spot; hence, it was possible to produce irradiation effects in the labyrinth. Two different types of macroscopic lesions have been observed: a small white patch in the bony wall with about 1-mm dia, and a local fragmentation of the bony capsule. Immediately after irradiation the animals showed symptoms of labyrinthine irritation, left-beating nystagmus, and tendency to fall to the right. Examination of the ampullae three weeks after irradiation revealed that the wall was thickened due to new-growth of bone, the crest had shrunk, the epithelium had atrophied, and the cupula had disappeared. Some sensory cells and supporting cells had completely disappeared, others showed different degrees of atrophy. Cellular lesions, though less pronounced, were found also in the secretory epithelium around the base of the crest. The effects of the first shot, which splintered the canal wall, included fragmentation of the bone and signs of a raised fibroblastic activity resulting in complete obstruction of the membranous canal. Thus the high-power laser beam can produce focal lesions in the vestibular part of the inner ear, which to some extent are similar to those previously noted after irradiation with diathermy and ultrasound. (BBB)

13009 RESPONSE OF HAIR TYPES IN MICE TO HIGHER DOSES OF X RAYS. Galbraith, Donald B. (Trinity Coll., Hartford, Conn.). J. Morphol., 118: 589-95(Apr. 1966).

Effects of x rays, particularly the greying response, on the fur of mice were examined. Mouse fur consists of large overhairs which include the monotrichs, awls, and auchenes, and the underfur which consists of the smaller and more numerous zigzags. Doses of x rays exceeding 1000 R delivered to resting hair follicles of mice caused a variable greying response ranging from 60 to 100%. To study specific response of zigzags and overhairs to irradiation, mice were exposed to 1200 and 1300 R of x rays and the response of hairs from a known area was compared with that of unirradiated controls and mice given 600, 800, and 1000 R. At the higher doses, variations in total greying response were paralleled by variations in the response of both zigzags and overhairs. There was relatively greater epilation of overhairs, and zigzags contributed most heavily to both the white and the totally pigmented fractions. The results therefore do not support the previous suggestion that the variable greying response is a function of a relative increase of pigmented overhairs in conjunction with selective damage of zigzags. Damaged follicles may regenerate from the upper external root sheath and thus incorporate melanocytes which reside in this area into the newly formed hair bulb. Thus the efficacy of regeneration, which is influenced by the physiological state of the integument, may be a critical factor in determining the extent of the greying response at higher doses of x-rays. (BBB)

13010 RESISTANCE OF THE GROUND SKINK, LYGOSOMA LATERALE, TO GAMMA RADIATION. Brooks, Garnett R. Jr. (Coll. of William and Mary, Williamsburg, Va.). Herpetologica, 18: 128-9(June 22, 1962).

A study was undertaken to determine gross effects of different whole-body doses of γ irradiation on the lizard, Lygosoma laterale. Specimens received total doses of 300, 600, 900, 1200, and 1500 R at a dose rate of 99.7 R/min delivered by ^{60}Co. Only 1 of 10 animals irradiated at the highest dose died within 30 days. Appearance and behavior of surviving animals during and after the 30-day period were indistinguishable from that of controls. No gross damage to any internal organs was seen except in a specimen that died in the 900-R group. In this lizard the testes were atrophied. The results show that L. laterale is very resistant to radiation. Other amphibians and reptiles are also highly resistant in comparison to most mammals. Two of the females (one in the 900-R group and another in the 1200-R group) laid two eggs each. The hatchlings appeared normal in comparison with other young from unirradiated females. Observation over a 3-week period revealed no abnormalities in structure and behavior. Since the doses used did not kill many specimens, a $LD_{50/30}$ for this skink could not be computed. (BBB)

13011 CO-CARCINOGENESIS IN THE HAMSTER CHEEK POUCH. Hamner III, James E. (National Inst. of Dental Research, Bethesda, Md.). J. Dent. Res., 45: 46-51(Jan.-Feb. 1966).

Experiments were performed to test the hypothesis that a cocarcinogenic effect on the buccal pouch mucosa of the hamster may be produced by irradiation and a chemical carcinogen, dimethylbenzanthracene (DMBA). Golden hamsters, 147 five-week-old males and females, were given a single dose of 500, 1000, or 2000 R externally to each buccal area over a 2.5-by-2.5-cm field from a skin-target distance of 25 cm. A 0.5 or a 0.05% solution of

DMBA dissolved in heavy mineral oil was painted on the medial walls of the cheek pouches 3 times per week, commencing 2 days following the single dose of x radiation. The x-ray doses used did not produce a cocarcinogenic effect in hamsters when used in conjunction with the painting of DMBA on the cheek pouch. Tumors appeared in cheek pouches painted with 0.5% DMBA in 7.5 to 12 weeks. Papillomas occurred slightly later when radiation was used in combination with 0.5% DMBA painting, and tumor induction was 100% in both groups in 22 weeks. The 2000 R plus 0.5% DMBA combination was lethal for the most hamsters (100% mortality in 13 weeks). The oral radiation death syndrome was observed in some of the hamsters given 2000 or 1000 R alone, also. The hamsters receiving 2000-R doses had some of the features occurring in human skin after irradiation: epilation, erythema, edema, ulceration, endothelial thickening, hyperkeratosis, and enlarged fibrocytes. The severe scarring and ulceration in the 2000-R group were caused by increased collagen formation and vascular occlusion with tissue necrosis. (BBB)

13012 RESISTANCE OF THE PRENATAL FEMALE MOUSE TO X-RAY STERILIZATION. Rugh, Roberts; Wohlfromm, Marlis (Columbia Univ., New York). Fertil. Steril., 17: 396-410(May-June 1966).

The effect of a single level of x-ray exposure (100 R) at various gestation ages, as measured by ultimate reproductive performance of the exposed females, was determined. Pregnant mice of the CF1 strain were exposed, from fertilization to 18 days, and the females resulting were fertility-tested for 6 months, beginning at 2 months of age. Of the 3245 litters produced for this study, 365 were from nonirradiated controls. Among the birth anomalies, persistent amnion occurred more frequently from offspring of the fetally irradiated females than among the controls (2.11% vs. 1.07%). The average number born dead or eaten by their mothers upon delivery was not significantly different. Average litter size was significantly lower only for females x rayed as 13-day-old embryos, which is correlated with the fact that oocyte production and DNA synthesis are most active beginning about day 13. Cyst formation in ovaries by 12 months of age occurred significantly more frequently among the females x rayed on days 12 and 13 (23.52% and 21.4%, respectively) than among the controls (13.15%). In addition to reduction in potential oocytes in the ovary, following fetal x irradiation, the fetally exposed female probably undergoes a general reduction in vitality and size, making it less able to produce normal fetuses. Therefore, ovarian sterilization may be the major, but not the exclusive, factor in reduced fertility of mice x rayed on gestation day 13. Embryonic and fetal female mice of any gestation age are less susceptible to x-ray sterilization than are the adults of the same strain. The only gestation stage at which they respond at all to 100-R x irradiation is day 13, which corresponds in development to about day 37 for the human. (BBB)

13013 LEUKEMOGENIC ACTIVITY OF CENTRIFUGATES FROM IRRADIATED MOUSE THYMUS AND BONE MARROW. Haran-Ghera, Nechama (Weizmann Inst. of Science, Rehovoth, Israel). Int. J. Cancer, 1: 81-7(Jan. 1966).

Leukemogenic activity of centrifugates from radiation-induced lymphomas and irradiated tissues of C57B1 mice was tested by injecting them directly into 5- to 7-day-old thymus implants beneath the kidney capsule in thymectomized irradiated hosts of the same strain. Of 12 centrifugates from radiation-induced lymphomas tested for leukemogenic activity, 6 were found to be active, inducing about 14% lymphomas at an average latent period of 166 days. Centrifugates from thymus plus bone marrow taken from irradiated donor mice 5 or 10 days after irradiation demonstrated leukemic activity at an incidence rate of up to 30%. Centrifugates of irradiated tissues taken 20, 30, 45, and 60 days after irradiation showed only borderline activity. Thymic tissue, taken from the same irradiated donor mice, transplanted beneath the kidney capsule of normal hosts, revealed neoplastic transformation only when taken from donors 30 days after completion of the irradiation. Urethane treatment increased the leukemogenic activity of the centrifugate. Centrifugates prepared from tissues taken from mice treated concurrently with x rays and urethane 10 days after completion of treatment yielded 75% lymphoma incidence, with a marked decrease in the average latent period. The first passage of this active centrifugate similarly revealed an 80% lymphoma incidence, with a short latent period. It is concluded that irradiation causes the release of a transmissible leukemogenic agent in C57B1 mice, and that urethane potentiates the activity of this agent. (BBB)

13014 THE SHAPE OF RADIATION SURVIVAL CURVES OF CULTURED MAMMALIAN CELLS IN VITRO. Sinclair, W. K. (Argonne National Lab., Ill.). pp 21-43 of STI-DOC-10/58.

The use of cultured mammalian cells for studies of basic interactions between radiation and processes occurring in cells at the time of exposure is discussed. Emphasis is placed on the interpretation of radiation survival data for single cultured mammalian cells. Topics discussed include technical or experimental factors that can vary the shape of the survival curve, the effect of heterogeneity among individuals of the populations studied, and the use of mathematical expressions or models to present data on survival of irradiated cells. (C.H.)

13015 RELATIVE EFFECTIVENESS OF IONIZING RADIATIONS IN RELATION TO LET AND THE INFLUENCE OF OXYGEN. Barendsen, G. W. (Radiobiological Inst., TNO, Rijswijk, Netherlands). pp 44-57 of STI-DOC-10/58.

Many biological effects of ionizing radiations on living cells and organisms are produced more efficiently by radiations with high linear energy transfer (LET) than by low LET radiations. Investigations on the relation between the relative biological effectiveness (RBE) and LET of radiations provide information on the number of ionizations that are required, and the dimensions of the value in which the effects must be produced to initiate the sequence of biophysical, biochemical, and biological changes that finally result in the death of the cell. Results are presented from an analysis of the RBE-LET relations for impairment of the proliferative capacity of cultured human cells induced by exposure to x, γ, α particles, deuterons, and neutrons of various energies exposed under oxygenated and anoxic conditions. It was concluded that existing information about the relative effectiveness of ionizing radiations in relation to LET and the influence of oxygen may be interpreted by the assumption that for impairment of the reproductive capacity of mammalian cells by ionizing radiations, a given amount of damage (corresponding to the chemical changes induced by 10 to 15 ionizations) is required within a volume with dimensions of the order of 100 Å. Only a relatively small fraction of the damage at the primary level, about 25%, was found to be oxygen dependent but this small fraction was found to be sufficient to result in oxygen enhancement ratios which, because of the shape of the cross-section versus LET relation, ranged from 2.8 at low LET to 1.0 at high LET. (C.H.)

13016 RADIATION QUALITY AND RBE FOR CHROMOSOME ABERRATIONS. Neary, G. J. (Medical Research Council, Radiobiological Research Unit, Harwell, Eng.). pp 58-62 of STI-DOC-10/58.

Primary lesions in chromosomes are not observable by cytological means. The observable aberrations result from the interaction of two chromosomes at a region where both have a primary lesion. Such regions or sites are quite small and the number of them in the cell nucleus may be comparatively few. Recent studies on chromosome aberrations in cells exposed to x radiation indicate that results are explained if it is assumed that the primary damage to a chromosome is produced by a single energy loss event, provided the essential structure of an interphase chromosome is a single macromolecule with a diameter small when compared with the spacing of energy loss events along tracks of low or medium high LET. It is postulated that this macromolecule is DNA. Thus the number of primary lesions in chromosomes is proportional to the radiation dose and is nearly independent of LET except at very high LET when the yield falls off. The mean effective number of sites of primary lesions is the product of the actual number times the probability of interaction occurs when both target chromosomes in a site have a primary lesion. If the two primary lesions are produced by independent tracks from ionizing particles the yield of chromosome aberrations is approximately proportional to the square of the dose and is independent of LET. If the two primary lesions are produced by the same track the yield is approximately proportional to the radiation dose and to the LET also. Results are reported from a comparison of aberration yields produced by x radiation and protons, observations of aberration yield from combined doses of high and low LET radiation, and observations on the yield of exchange aberrations in Tradescantia microspores as a result of two track exposures. It is pointed out that for aberration production, as for cell killing, the simple basic processes will be overlaid and their expression somewhat distorted by processes of recovery and repair that vary at different stages of the cell cycle. (C.H.)

13017 DISTRIBUTIONS OF HIT-NUMBERS IN SINGLE TARGETS. Fowler, J. F. (Hammersmith Hospital, London). pp 63-80 of STI-DOC-10/58.

The distinction between multihit, or single target models of cytological damage in irradiated biological systems and multitarget, or single list, models is discussed. A biological model is presented for relating the surviving proportion of an irradiated population of cultured cells or bacteria to the absorbed dose. The model is based on the physical facts of energy deposition in small volumes and on the results of cell survival experiments over a wide range of LET. It is basically a multihit model applied first

to a single target volume, but is also applicable to situations where only one potential target has to be inactivated to kill the organism. Emphasis is placed on the amount of energy locally deposited in certain sensitive volumes called target volumes. Applications of the model in studies on cell survival of x irradiated cultured human kidney cells are reported. Results are compared with experimental survival curves for 8 irradiated cell lines computed using multihit models. (C.H.)

13018 STOCHASTICS OF RADIATION EFFECTS. Hug, O.; Kellerer, A. (Univ., Munich). pp 114-27 of STI-DOC-10/58.

A mathematical model of radiation dose-effect relationship in biological systems is presented that attempts to include the kinetics of radiation induced processes as well as the dynamical character of the vital objects. The model includes the different stochastic factors that determine the radiation effect. The limitations of conventional models of radiation injury and the stochastic nature of biological effects that contribute to individual response to radiation are discussed. (C.H.)

13019 PROLONGATION OF RENAL HOMOGRAFT SURVIVAL BY INDWELLING BETA IRRADIATION. Wolf, James S.; O'Folghludha, Fearghus T.; Kauffman, H. Myron; Hume, David M. (Medical Coll. of Virginia, Richmond). Contract AT(40-1)-2459. Surg. Gynecol. Obstet., 122: 1262-8(June 1966).

A method is described for producing profound lymphopenia, without any demonstrable detrimental alterations, by suspending ^{90}Y implants intra-arterially in dogs. An implant consisted of 10 ^{90}Y pellets, (2 by 3 mm, weighing 1.2 g) placed in a linear fashion in silastic tubing. Each pellet had an activity of 10 mC and emitted a calculated mean cell dose of ~12,500 R during the time employed. Kidney homotransplants were preformed in dogs undergoing immunosuppressive therapy by irradiation of the circulating blood. All animals showed a marked lymphopenia that started within 12 hr after implantation of the ^{90}Y. The lymphocyte count remained at levels of less than 500 lymphocytes/mm^3 for 3 weeks before returning slowly to normal and a loss of lymphocytes from lymph nodes and spleen occurred consistently. Significant prolongation of functional survival of the homografts over those of the control series was achieved; the longest homograft survival was 34 days. The animals also showed immunologic depression to keyhole limpet hematocyanin antigen. Thus, lymphopenia induced by irradiation of circulating blood decreased the dog's immunologic response to both foreign protein and organ transplants. In all treated animals there was little change in kidney size or structure during the first week; cessation of homograft function occurred while the graft showed minimal cellular infiltration in some of the animals. No permanent homograft survivals were obtained. (BBB)

13020 EXPERIMENTAL STUDIES ON THE EFFECTS OF INTERNAL RADIATION OF ^{90}Sr ON THE MOUSE. Hayashi, Mitsuaki (National Inst. of Animal Health, Tokyo). Jap. J. Vet. Res., 13: 53(June 1965).

Internal radiation effects of ^{90}Sr on mice of the dd strain, four weeks old and weighing 15 to 20 g, were studied. Total retention of ^{90}Sr was 28.4% of the injected dose on the 5th day, 18.9% on the 15th day, and 17.6% on the 45th day after intraperitoneal injection of ^{90}Sr. At 24 hr, ^{90}Sr concentrations (cpm/mg of Ca) in blood, bone, and organs were almost the same. However, the ^{90}Sr concentration (cpm/mg of Ca) in blood was almost one-tenth of that in bone by the 15th day. Leukocyte counts on the 30th day after ^{90}Sr injection were slightly, moderately, and severely decreased when doses of 0.2 μC/g, 0.4 to 0.8 μC/g, and 1 to 2 μC/g, respectively, were given. The LD_{50} at 30 days for ^{90}Sr by the intraperitoneal route was 4.0 μC/g. The ^{90}Sr concentrations in bone were determined. The incorporations of ^{32}P and ^{45}Ca into the bone were inhibited markedly after the injection of ^{90}Sr. On the 10th day after the intraperitoneal injection of 2 μC/g of ^{90}Sr the incorporation of ^{32}P into the spleen and lymph nodes rose considerably, whereas the liver showed a moderate increase. Incorporation of ^{32}P into various phosphorus fractions in the spleen and liver was observed. In liver the synthesis and utilization of phospholipids markedly increased, but in spleen the synthesis and turnover of nucleic acids, phosphoproteins, and acid-soluble phosphorous compounds, as well as phospholipids, markedly increased. Oxygen consumption of liver tissue was almost the same as that of the control animals, but the activity of ATPase increased markedly as glycogen level decreased. (BBB)

13021 EFFECT OF γ IRRADIATION (^{60}Co) ON PUPAE OF BOMBYX MORI L. Babos, L.; Gubicza, A.; Lukacsovics, F.; Molnar, I. (Biological Research Inst., Tihany, Hung.). Ann. Biol. Tihany, 29: 3-9(1962). (In German).

Pupae of the Varo variety were irradiated with from 300,000 to 400,000 R of ^{60}Co radiation. All of the spring pupae that received 300,000 R died within 10 to 12 days after their metamorphosis. The irradiated pupae that lived reached wt equilibrium within 85 to 90 days under conditions of 65 to 75% humidity at 22°C. Fungal and bacterial contamination did not take place during the drying period. From 9 to 11% of the pupae were liquified in the cocoons preserved with ^{60}Co irradiation. A mortality of 2.1% by infection was observed in the pupae killed and dried by means of high temperature. Of the pupae killed by disease, 92% were infected with bacteria (Staphylococcus and Bacillus bombycis) and 8% were infected with virus disease (polyedrosis). The wt of the irradiated pupae was less than that of the controls. The fat contained in the pupae killed by high temperature was 40% greater than in the pupae killed by irradiation. The lower wt and fat concentrations appeared to be direct results of irradiation. Formation of ozone may have been a factor producing these results. (BBB)

13022 EFFECTS OF RADIATION FROM FALLOUT. Lancet, 1: 1254-5(June 4, 1966).

A new evaluation of the possible effects on populations of fallout from nuclear test explosions made in a report to the Medical Research Council (United Kingdom) is reviewed. The basis for estimating risks is taken from new data submitted to the International Commission on Radiological Protection, which are expressed as the numbers of additional cases of leukemia, thyroid cancer, and all fatal cancers that might be expected over and above the natural incidence if a population of one million persons was exposed to 1 rad of radiation (about 10 times the average annual background dose). The available information now suggests that, after one million people were exposed to this hypothetical dose, a total of 20 additional cases of leukemia might arise, over the next 10 to 20 yr. All other fatal malignancies might increase by another 20 cases, as well as 10 to 20 additional cases of thyroid cancer. The natural incidence in the United Kingdom of all types of fatal cancer (including leukemia) is about 2200 cases/million/yr. The estimate of genetic risk is 1 additional case of visible genetic abnormality in the offspring of each million persons exposed. The report also discusses countermeasures that might be taken against fallout. (BBB)

13023 COMPLICATIONS OF POLYCYTHEMIA VERA. Wasserman, Louis R.; Gilbert, Harriet S. (Mt. Sinai Hospital, New York). Seminars Hematol., 3: 199-208(July 1966).

Complications of the disease are considered, especially in relation to leukemia and other myeloproliferative disorders that may follow treatment with ^{32}P and other agents. About 10 to 15% of cases undergo a transition to a more malignant form of myeloproliferation in which one primitive cell type begins to predominate until there evolves a picture resembling acute blastic leukemia. Whether this is a spontaneous complication the development of which is inherent in the nature of the disease, or whether it arises as a result of the type of therapy used is controversial. Various forms of irradiation have been used in controlling cellular proliferation, and most patients with the disease have been treated with either whole-body irradiation, x ray to the long bones, x ray to the spleen, or radiophosphorus. In view of the complications occurring in untreated patients, and in the absence of other equally effective forms of therapy, these modalities have been most effective in controlling the disease. Retrospective analyses comparing the incidence of acute leukemia in patients with polycythemia vera treated with and without radiation suggest a strong relation between the occurrence of a terminal acute leukemia and prior irradiation. However, caution must be exercised in interpreting these findings, for reasons which are discussed. The question of length of survival and types of complications that develop in patients not treated at all or treated by phlebotomy alone, as compared with those treated with radiation, remains to be resolved. (BBB)

13024 POLYCYTHEMIA: INTRODUCTION. Gardner, Frank H. (Presbyterian-Univ. of Pennsylvania, Medical Center, Philadelphia). Seminars Hematol., 3: 175-80(July 1966).

A series of reports on the treatment of polycythemia is summarized, in which attempts are made to assess the effectiveness and hazards of ^{32}P therapy. While there was general agreement that an initial bleeding program should be tried, most symposium members believed that some form of myelosuppressive therapy should be used. (TSS)

13025 COMMENTS ON TREATMENT OF POLYCYTHEMIA VERA LEUKEMIA AS A COMPLICATION OF POLYCYTHEMIA VERA. Nathan, David G. Seminars Hematol., 3: 230(July 1966).

Data relating to the causation of leukemia in ^{32}P-treated patients with polycythemia are briefly reviewed, particularly with regard to the ethnic origin of the polycythemia vera patients who have developed leukemia following ^{32}P therapy. Polycythemia vera is a rare disease that is seen in the United States to a large extent in Jews of Eastern European origin. Acute leukemia may also be seen in Jews in disproportionate numbers. Recent data suggest that leukemia and cancer of all forms may be less common in oriental Jews than in European Jews. Although a high incidence of

leukemia has been found in ^{32}P-treated American polycythemia vera patients, no cases of leukemia have been observed in 107 English polycythemia vera patients who received radiation therapy between 1944 and 1962. There is reason to believe that there were more European Jews in the American series. These facts lead to speculations about undue susceptibility of Jews to leukemogenic agents. Possibly physicians should be particularly cautious about the use of ^{32}P in Jews of European origin until more facts become available. (BBB)

13026 X RAY DIAGNOSIS OF OSTEONECROSIS OF THE HIP BONE AFTER X RAY–RADIUM RADIATION OF FEMALE GENITAL CARCINOMA. **Fries, Giselbert (Univ., Hamburg). Strahlentherapie, 132: 113-27(Jan. 1967). (In German).**

An osteonecrosis with secondary changes was observed in 21 hips of 15 patients with genital tumors who had been irradiated with x rays and radium. The changes in roentgenograms during the course of the disease are reported and special consideration is given to early changes. The importance of the early changes and their possible treatments (nailing of the head of the femur) are discussed. A request is made, that irradiated patients be advised about a possible bone damage by the irradiation; the necessity of regular and long term control examinations is pointed out. (auth)

13027 SIGNIFICANCE OF THE SPLEEN IN RADIATION INJURIES OF MAMMALS. II. REPORT: SURVIVAL RATE AND SERUM PROTEINS AFTER SPLENECTOMY OF DOGS. **Ladner, Hans-Adolf (Univ., Freiburg i. B. Univ., Mainz). Strahlentherapie, 132: 51-8(Jan. 1967). (In German).**

Transplantation experiments in dogs to influence the immunobiological events produced by splenectomy, showed a therapeutic effect of the operative procedure upon the survival rate after whole body irradiation. The influence of a bilateral whole-body x irradiation with 300 kV with an LD_{95} followed by splenectomy or laparotomy upon the survival rate as well as upon the serum proteins was investigated in 45 dogs. Splenectomy done 24 hours after irradiation resulted in an increase of the survival rate from 5% to 81%. Whole body irradiation in this dose range caused a hypalbuminemia as well as an increase of the α_2- and β-globulins several days before the deaths of the animals (16th to 23rd day p.r.); while these radiation induced changes could be observed only to some extent after splenectomy 24 hours after irradiation. Further investigations are being done to clarify the special role of the spleen in the radiation and immune events of several mammals. (auth)

13028 STUDIES ON THE MORPHOLOGY OF X- AND RADIUM-IRRADIATED MOUSE OVARIES. II. REPORT: OBSERVATIONS ON THE FOLLICLE-, THECA-, AND LUTEIN CELLS. **Jostes, Erhard; Scherer, Eberhard (Univ., Marburg, Ger. Univ., Muenster, Ger.). Strahlentherapie, 132: 59-78(Jan. 1967). (In German).**

A continuation of previous investigations, concerning electron microscopic studies of the ovaries of white mice revealed marked early damage of the follicular cells as well as, to a lesser extent, the theca cells after a single whole body irradiation with 100R as well as after a fractionated irradiation with 1.2R/day. A significant decrease in the follicular cells was observed; surviving cells showed in both experimental series an increased metabolism. In the case of the fractionated irradiation, repair events were more evident than after the single irradiation with a high dose. The corpus luteum cells were observed to be relatively radiation resistant. (auth)

13029 MORPHOLOGICAL CHANGES IN OVARIES OF RATS FOLLOWING CONTINUOUS SMALL DOSES OF RADIATION ADMINISTERED DURING INTRAUTERINE DEVELOPMENT. **Vorisek, Premysl; Jirasek, Jan E. (Anstalt fuer Muetter- und Kinderfuersorge, Prague). Strahlentherapie, 132: 79-89(Jan. 1967). (In German).**

After reviewing morphological examinations of radiation damages of the ovary, the influence of small continuous doses of ^{60}Co-γ-rays (2.5 R/24 hours) upon the ovaries of rats administered during intrauterine development is reported. The total dose from the 1st to the 20th day of pregnancy was 50 R. The structure of the ovary was studied using serial paraffin sections of newborns as well as 25, 60, and 120 day old rats. Photomicrographs were made of numerous radiation-induced changes of the follicular apparatus and of the degenerative changes of the corpus luteum. Furthermore, a premature ovulation was found in 60 day old rats after the intrauterine irradiation. (auth)

13030 INFLUENCE OF FIELD SIZE ON WOUND HEALING. BURNING EXPERIMENTS ON PIG SKIN. **Renner, Karlheinz (Strahlenklinik Janker, Bonn). Strahlentherapie, 132: 33-9(Jan. 1967). (In German).**

Studies concerning the radiation tolerance limit of the skin were done using late effects and healing times of radiation necroses as criteria. The relationship between healing and field size (the dependency of radiation reactions on field sizes) were always considered to be a radiobiological peculiarity. A heat-burn experiment done with pig skin, demonstrates that this is a general problem in the wound healing. The healing of heat-burn necroses also shows a distinct dependency upon the field size. Smaller defects are covered more rapidly with epithelium. (auth)

13031 KARYOMETRIC STUDIES IN IRRADIATED GRAFTED TUMORS WITH 180 keV X RAYS AND WITH 30 MeV FAST ELECTRONS. II. OSCILLATIONS INDUCED IN TYPE II CELLS. **Paolini, F. A. (Univ., Zurigo, Italy. Univ., Pavia, Italy). Radiol. Med., 52: 823-32(Aug. 1966). (In Italian).**

Karyometric studies were performed on the nucleolus, nucleus, and cytoplasm of type III cells from Ehrlich's tumor, irradiated with either 180 keV x rays or 30 MeV fast electrons. The results obtained lead to the conclusion that both 180 keV x rays and 30 MeV fast electrons induced a progressive increase, with raising of the doses administered, of the cellular volumetric quotients, as well as variations in the percentage frequency level of cell reproduction. The effects induced appeared greater when 180 keV radiations were used. Statistical examination of the linear regression not only confirmed what was observed for type I cells, but revealed the variability of the RX/β ratio, which is more obvious in the comparison between the various cell parts considered than with regard to the two types of cells observed up to now. (C.H.)

13032 THE INFLUENCE OF ANOXIA INDUCED BY RESPIRATION OF LEAN MIXTURES ON GUINEA PIGS SUBJECTED TO HEMILETHAL DOSES OF X RADIATION. II. STUDY OF HEMATOLOGICAL AND BONE MARROW CHANGES. **Mazzella, G.; Meldolesi, U. (Univ., Catania, Italy). Riv. Med. Aeron., 24: 552-68(Oct.-Dec. 1961). (In Italian).**

The effect of hypoxia on bone marrow and blood cell radiosensitivity was studied. Hypoxia was obtained by the animals breathing a 6.6% oxygen mixture passed at a rate of 3 l/min into a Plexiglas chamber for 15 min before and for 18 min during x irradiation with whole-body doses of 350 R (the $LD_{50/30}$ for these guinea pigs). Blood and bone marrow cells were studied at 1 hr and 1 to 30 days postirradiation. The parameters examined included hemoglobin, hematocrit, red cells, white cells, leukocyte index, and reticulocytes. Various types of bone marrow cells were also counted and the granuloblast/erythroblast ratio was determined. No significant differences were noted when these data were compared to those found for guinea pigs breathing air. Hence, under the conditions studied, hypoxia did not alter the radiosensitivity of the hematopoietic system of guinea pigs. (BBB)

13033 ANTILIPID AND ANTITREPONEMAL ANTIBODIES IN RABBITS SUBJECTED TO PANIRRADIATION. **Epifanio, G. (Univ., Palermo, Italy). Radiol. Prat , 15: 55-63(Jan.-Feb. 1965). (In Italian).**

Rabbits were inoculated intracardially with a pathogenic strain of Treponema pallidum and subjected to various whole-body doses of 200-kV x rays or ^{60}Co γ rays. Single doses of 100 to 250 R were given over intervals, up to 119 days, for total doses of 200 to 2100 R. Many different dose schedules, varying the intervals between the treponemal inoculation and irradiation were used. Antilipid antibodies were followed in serum, using cardiolipin as the antigen, by the complement-fixation procedure. Complement-fixation tests were also conducted with the soluble protein antigen (RPCF), and with a suspension of Reiter's treponemas. No significant differences in any of these antibody levels were found, even after high-dose irradiation, when the results were compared with those from unirradiated rabbits. It is concluded that antitreponemal immunity is not depressed by x or γ radiation when given in a prolonged schedule with progressively increasing doses or when administered before inoculation of the treponemas. (BBB)

13034 HISTOLOGICAL CHANGES IN INTERRENAL TISSUE OF THE GOLDFISH, CARASSIUS AURATUS, FOLLOWING X-IRRADIATION. **Aoki, Kazuko (National Inst. of Radiological Sciences, Chiba, Japan); Egami, Nobuo; Arai, Ryoichi. J. Radiat. Res. (Jap.), 7: 83-90(June 1966).**

Goldfish, Carassius auratus, irradiated with 4 kR or more of x rays and kept at 23°C invariably died around 10 days after irradiation, while those exposed to 1 kR or less survived for at least one month under the same temperature condition, without showing any harmful effects. Interrenal cells located in the head kidney of the goldfish decreased in size after hypophysectomy and underwent a hypertrophy following administration of mammalian ACTH. Six to nine days after whole-body irradiation with 1-16 kR of x rays, interrenal cells were definitely enlarged. In hypophysectomized fish a similar x irradiation failed to cause interrenal cell hypertrophy. Irradiation of the head of goldfish resulted in a hypertrophy of interrenal cells, even if the posterior part of the body containing the head kidney was shielded from x rays. These findings seem to suggest that, in the goldfish, secretion of ACTH from

the hypophysis increases at least for a period following x irradiation. (auth)

13035 EFFECT OF X RAY IRRADIATION ON THE GROWTH OF THE FOWL EMBRYONIC FEMORA AND THE REPAIR OF ITS INJURIES IN TISSUE CULTURE. Nunotani, Takeshi (Kanazawa Univ., Japan). Juzen Igakukai Zasshi, 71: 338-54(Mar. 1965). (In Japanese).

Fractured and non-fractured femora from 9-day old fowl embryos were x irradiated with doses from 300 to 2000 R and then cultured by the roller tube method. After varying lengths of time histochemical and histopathological studies were made. Growth and differentiation proceeded rapidly during the first 9 days and then proceeded more slowly, and after 2 weeks degeneration of cartilage cells were observed. Repair of fractured femora was brought about by joining of the injured perichondrium margins, proliferation of hypertrophic cartilage cell layer, and resorption of necrotic cartilage. Various effects of radiation doses on growth and fracture repair were observed. (H.L.W.)

13036 A METHOD FOR THE EPIDEMIOLOGIC ASSESSMENT OF PERIODONTAL HEALTH-DISEASE STATE IN A BEAGLE HOUND COLONY. Rosenberg, H. M.; Rehfeld, C. E.; Emmering, T. E. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.). J. Periodontol., 37: 208-13(May-June 1966).

Examination procedures are described for a group of beagle hounds maintained in controlled environments for studies on the effects of bone-seeking and nonbone-seeking radioisotopes. Such a colony is universally affected by periodontal disease and the administration of bone-seeking isotopes has a markedly destructive effect on the teeth and periodontium of the animals. The experimental, isotope-treated animals lose their teeth at a greater rate than an aging control group. In other observations of adult beagle hounds in the colony at Argonne National Lab prior to irradiation, the occurrence of calculus and periodontal disease appeared to be enzootic. A detailed description is given of the dental findings along with the methods used. On the basis of the results a concept is advanced whereby an attempt can be made to further understand periodontal disease by the creation of a control biological working model of the disease. The observations indicated that the unique clinical similarity of periodontal disease in the observed healthy beagle hound colony and a human population makes this animal an excellent working model for evaluating and gaining further knowledge of periodontal disease. (BBB)

13037 X-IRRADIATION OF LATERAL-LINE PRIMORDIA IN AMBYLSTOMA. Piatt, Jean (Univ. of Pennsylvania, Philadelphia). J. Exp. Zool., 162: 193-208(July 1966).

Effects of x radiation on the developing lateral-line system in the salamander were studied. This system is peculiarly suitable for studies of irradiation damage because its elaboration depends upon extensive migration of cells as the usual mitotic multiplication and differentiation. Embryos of Amblystoma punctatum were x-irradiated with 500 to 2000 R at stages 28 to 30. A rectangle of ectoderm including postauditory placodal material was transplanted orthotopically from the right side of irradiated embryos to nonirradiated hosts of the same age. Control experiments consisted of the same operation between nonirradiated embryos. Animals were studied at stage 46 to determine the effects of irradiation upon development of lateral-line migratory primordia, nerves, and ganglion. The dorsal lateral-line was most affected by irradiation, averaging 90% less organs and 85% less nerve fibers than normal. Midbody lateral-line averaged 65% less organs and 55% less nerve fibers. There was no reduction in number of ventral lateral-line organs and scarcely any in number of nerve fibers. Number of lateralis ganglion cells averaged 62% less than normal. Control animals developed normal numbers of organs and nerve fibers in all 3 lateral-lines and showed no appreciable reduction of ganglion cells on the operated side. It is concluded that x irradiation severely affects the development of the trunk lateral-line system. This is effected through suppression of both the activity and size of the migratory primordium as well as reduction of innervation. The data indicate the two effects are mutually independent and that damage to the migratory primordium is, perhaps, the primary radiation effect, rather than reduction of innervation through damage to the ganglion primordium. (BBB)

13038 STATISTICAL OBSERVATION OF MALIGNANCY DEATHS AMONG ATOMIC BOMBING CASUALTIES. (FOURTH REPORT). Oho, Gensaku; Machi, Sui Nagasaki Igakkai Zasshi, 38: Suppl., 117-30(Dec. 1963). (In Japanese).

Deaths from malignancy of the casualties in Hiroshima from 1951 to 1960 showed a slight increase over earlier periods. The age-specific malignancy deathrates of casualties in the city are always higher than for noncasualties of Hiroshima county and of Japan in general. The age of inception of the malignancy showed no tendency to decrease. Leukemia and aleukemic leukemia age-specific deathrates among casualties were far beyond those of the whole country. The leukemic deathrate among casualties was similar in various age groups. For casualties within 1.0 km of the hypocenter the malignancy deathrates among males and females exceeded those of the whole country. Results suggest that the increased leukemia incidence is related to the distance to the hypocenter, i.e., the shorter the distance the higher the incidence, and that this is due to the primary radiation from the atomic bomb. Other forms of malignancy are related to the persons entering areas of the city near the hypocenter after the bombing. Secondary radiation from radioactive debris may be involved in carcinogenesis in this group. (TSS)

13039 CLINICAL OBSERVATION OF ATOMIC BOMBING CASUALTIES. PART 3. Yokota, Soichiro (Nagasaki Atomic Bomb Casualty Hospital, Japan). Nagasaki Igakkai Zasshi, 38: Suppl., 135-40(Dec. 1963). (In Japanese).

Malignant and non-malignant diseases diagnosed from October 1962 to September 1963 are reported. Malignancies were most prevalent in gastric, thyroid, and hepatic sites. A two-fold increase over the previous year noted in liver cirrhosis, could not be correlated with exposure to atomic bombing. However, the high hypothyroidism to hyperthyroidism ratio was conceivably related to the fact that atomic bomb casualties are more likely to develop thyroid cancer. One microcephaly case was a fetal casualty within 1100 m of the hypocenter. (TSS)

13040 SOME OBSERVATIONS ON THE FINE STRUCTURE OF THE LUTEIN CELLS OF X-IRRADIATED RAT OVARY. Flaks, Bojan; Bresloff, Paul (Univ. of Leeds, Eng.). J. Cell. Biol., 30: 227-36(Aug. 1966).

Electron microscopic studies were conducted on the ovaries of 10- to 13-week-old rats, exteriorized and irradiated with sterilizing doses of x rays. Following treatment, the animals entered a phase of constant vaginal cornification. Animals were killed 8 to 12 weeks after the onset of this phase, and their ovaries were prepared for electron microscopy. Lutein cells from these ovaries were compared with those from sham-irradiated controls. The cytoplasm of lutein cells from experimental animals was characterized by an increase in the amount of agranular endoplasmic reticulum and by an increase in the number of mitochondria. These mitochondria were more variable in external form and often possessed increased numbers of villiform cristae. Other features noted were a decrease in the amount of cytoplasmic lipid granules and an increase in cell size and surface irregularity. The significance of the morphological findings is discussed in relation to ovarian hormone production in animals sterilized by x irradiation. None of the changes described can be regarded as being caused specifically by x irradiation. The general appearance of the cytoplasm of lutein cells resembles that of luteotropin-stimulated cells and was compatible with that of active steroid-secreting cells. As the lutein cells described are apparently the only cells present in x-ray sterilized ovaries which appear, morphologically, to have the capacity for steroid production, these cells were probably responsible for the constant vaginal cornification observed. (BBB)

13041 PLURIPOTENTIAL STEM CELLS IN MOUSE EMBRYO LIVER. Taylor, R. B. (National Inst. for Medical Research, London). Brit. J. Exp. Pathol., 46: 376-83(Aug. 1965).

Mouse embryo liver was obtained at a stage before lymphoid differentiation of the thymus becomes apparent (12 days) and examined for its capacity to repopulate the thymus of irradiated recipients. If lymphoid stem cells were thus demonstrable at this stage, it would suggest that they might be the source of the first-appearing lymphocytes in the embryonic thymus. Embryo liver and irradiated bone marrow were also examined for dissociation between lymphoid and hematogenous potentialities such as might indicate separate populations of stem cells. The principle of the experiments was to mix the cells under test in known proportion with normal bone marrow cells which served as a standard, and to inject the mixtures into irradiated recipients. The number of mitoses (distinguished by the T6 chromosome) of test relative to standard cell origin found in the recipient was taken as a measure of the proliferative capacity of the test cells relative to normal bone marrow. As obtained from the recipient thymus this figure was taken to relate to cells of lymphoid potentiality, and as from the bone marrow to cells of mainly erythroid and myeloid potentialities. Recipient mice of the co-isogenic CBA and CBA/T6T6 strains were irradiated with 900 R immediately before the cell transfers, all made intravenously. Recipient mice were injected with CBA embryo liver and CBA/T6T6 bone marrow in various proportions, and 3 to 8 weeks later chromosome preparations made from thymus and bone marrow. The results showed that the proliferative capacity of both 13- and 15-day embryo liver was about equal to that of normal adult bone marrow, as assessed in either recipient thymus or bone marrow, and that stem cells capable of lymphoid differentiation are present equally in adult bone marrow and in embryo liver at a stage (12 days) before lymphocytes be-

come evident in the thymus rudiment. In bone marrow taken from mice 9 weeks after irradiation the proliferative capacity was found to be depressed to the same extent (1%) whether assessed in bone marrow or thymus. A karyotypically-distinct clone of cells that arose in the irradiated donors was present in both these tissues. This evidence is compatible with the hypotheses: that both hemopoietic and lymphopoietic capacities can reside in the same cell; and that this cell is a precursor of the thymus lymphocytes both in adult and embryonic life. The failure to detect colony-forming cells in the neonatal thymus indicates either that the pluripotential stem cells become determined on a lymphoid pathway before entering the thymus, or that if they do enter the thymus as such, they must become determined soon afterwards. (BBB)

13042 EFFECT OF IONIZING IRRADIATION ON NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM CULTURED IN VITRO. Stefanicka-Wiechowa, Alina; Kowalska, Zofia (Lab. of Neurosurgical Pathology, Krakow). Arch. Immunol. Therap. Exp., 14: 759-66(1966).

The studies were performed in 12 cases with various tumors of the central nervous system by the method of tissue culture according to Maximov, Hintsche and in Leighton tubes. The x-irradiations with 8000 to 16000 R were given in massive or divided doses. The irradiated cultures were observed for periods of a few days to several weeks. Distinct post-irradiation changes occurred in cases of anaplastic gliomas and in medulloblastomas of the cerebellum. The post-irradiation changes were expressed by retraction and flexion of the cell processes, the appearance of granules in the cytoplasm and its vacuolization, pyknosis of the nuclei and fragmentation of the cytoplasm. In anaplastic gliomas in which a 16,000 R dose was applied, after ten weeks there were observed many cells which did not show any postirradiation changes. Highly differentiated astrocytomas were not susceptible to ionizing irradiation. (auth)

13043 EXPERIMENTS ON THE INDUCTION OF TUMOR-SPECIFIC RESISTANCE AGAINST ISOLOGOUS TRANSPLANTS OF SARCOMAS INDUCED BY IMPLANTATION OF PLASTIC PELLETS. Horn, Karl-Heinz; Pasternak, Guenter; Graffi, Arnold (Inst. for Cancer Research, Berlin). Arch. Immunol. Therap. Exp., 14: 737-42(1966).

Spindle-cell-sarcomas, induced in inbred mice by implantation of polyvinylchloride and silicon-cautchouc pellets, were tested with regard to specific antigenicity. The animals were immunized by ligation of intracutaneously implanted isologous tumor transplants and by injection of x-irradiated tumor tissue. The challenge tumor dose was given subcutaneously or intravenously. Two of the 8 tested tumors were statistically significant antigens, whereas 3 tumors possessed questionable antigenicity. The tumor-specific antigenicity of these plastic-induced tumors is very low compared with tumors induced by hydrocarbons or ultraviolet irradiation. (auth)

13044 LIFE SPANS OF COMPETENT IMMUNOLOGICAL CELL POPULATIONS IN RADIATION CHIMERAS OF THYMECTOMIZED MICE. Duplan, Jean-Francois (Institut du Radium, Paris. Fondation Curie, Paris). Compt. Rend., Ser. D, 263: 1917-20(Dec. 7, 1966). (In French).

Beginning at 400 days after irradiation, all of the isogenic thymectomized radiation chimeras that were restored by the spleen or fetal liver lost their immunological reactivity. In the absence of the thymus, the stem cells can no longer maintain their initial level of production of immunologically competent cells; furthermore, the independent cells of the thymus have lost their ability to multiply. (H.L.W.)

13045 GROSS SEQUELAE OF FETAL X-IRRADIATION OF THE MONKEY (MACACA MULATTA). II. FUNCTIONAL EFFECTS REVEALED BY EEG, ERG, AND EKG RECORDINGS. Rugh, R.; Duhamel, L.; Skaredoff, L.; Somogyi, C. (Columbia Univ., New York). Atompraxis, 12: 519-24(Oct. 1966).

EEG recordings showed spikes, asymmetry, and asynchrony in the irradiated monkeys but not in the control; and all three monkeys were within the normal range of variability for normal monkeys. ERG recordings of the monkey receiving the higher exposure showed permanent retinal damage comparable in function to a much reduced source of stimulation. This same monkey showed evidence of myocardial damage according to the EKG. The whole blood analysis did not reveal anything significant suggesting that if the blood remains within normal range, survival is very likely. The over-all effect of fetal irradiation of the monkey is similar to previous findings with other and lower mammals, indicating deficiencies due to loss of cellular elements particularly sensitive at the time of exposure. (auth)

13046 STUDY OF THE EFFECT OF γ RADIATION ON DIAPAUSAL OVA OF BOMBYX MORI L. (LEPIDOPTERA). Lukacsovics, Ferenc; Gubicza, Andras (Biological Research Inst., Tihany, Hung.). Ann. Biol. Tihany, 30: 67-71(1963). (In German).

The sensitivity of ova of the Varo type of B. mori, used extensively in Hungary, to γ irradiation from ^{60}Co was studied during the diapause phase of ontogenesis. The injurious effects of radiation on the development of the embryo, hatching of the larva, and the numbers of individuals hatched were studied. Until hatching, the O consumption was the only manifestation accompanying the diapause that indicated embryonal development well. The O consumption of Varo ova exposed to various doses of γ radiation was the same as in unirradiated ova, at 5°C. After irradiation ova incubated at 15°C already showed differences in respiration even at the beginning of embryonal development, depending on the size of the dose. At 20 to 22°C the O consumption between control ova and ova irradiated with 117 R was not statistically significant. After irradiation with 1053, 10,500, and 47,600 R embryonal development rates of ova in the last stages of development were less than in control ova. The duration of embryonal development became protracted in groups of ova that received over 585 R. At 40 R the duration of larval hatching reached its max. Percentage decreases in hatching (deaths) began at dose values over 1000 R. At 10,500 R the hatching rate was only 0.5%. The LD_{50} value was calculated to be 4767 ± 117 R. (BBB)

13047 EFFECTS OF RADIATION FROM A ^{60}Co SOURCE ON MATURE OVARY CYCLES OF A MAC ATROPARVAS. Lecis, A. (Univ., Cagliari, Italy). atti Ass. Genet. Ital., 11: 267-75(1966). (In Italian).

Following a study of the development of the ovaries in both pupae and adults of Anopheles maculipenois Atroparvus, females of different ages were irradiated with two doses of γ rays. The doses used were of 4000 R and 6000 R produced from ^{60}Co source, regulated to give 180 R/min. Irradiated pupae, in which the process of the maturation of the eggs had not yet begun, deposited, as females, a number of eggs inferior to the controls; the hatchability of these eggs was also inferior to that of the controls. Virgin females in which the first nutritive cells had appeared, irradiated a few hours after emergence, were not affected by the treatment, depositing eggs in numbers equal to those of the control females; nearly all these eggs hatched. Virgin females irradiated in an advanced stage of development (the eggs were already in metaphase I) deposited eggs in about equal numbers to those of control females; however the hatchability of these eggs was about 50% of the controls at least as regards the first ovodeposition. (auth)

13048 THE RADIOSENSITIVITY OF THE OOCYTES OF ARTEMIA SALINA. Giavelli, S.; Cervini, A. (Univ., Milan). Atti Ass. Genet. Ital., 11: 292-300(1966). (In Italian).

The radiosensitivity of the oocytes of the Sète diploid parthenogenetic strain of Artemia salina was studied with different x-ray doses (250, 500, 750, 1000, 1250, 1500 R). X-ray treatments were performed at 22° or 0°, in order to analyze whether the radiosensitivity of the oocytes in prophase might be modified by low temperature. The x-ray damage scored was the oocyte-inhibition to hatch. The results do not demonstrate any significant difference between the two treatments. It was concluded therefore that pretreatment with low temperature did not modify the x-ray effect. (auth)

13049 BLASTOGENIC ACTION OF 120-MeV PROTONS. Streltsova, V. N.; Moskalev, Yu. I. Radiobiologiya, 6: 660-5 (1966). (In Russian).

In rats, irradiated with 120-MeV protons, the frequency of benign and malignant tumors of the mammary gland, blood-forming tissues, thyroid gland, suprarenal gland, hypodermic tissue, kidney, bones, uterus, and prostate gland increases. The total frequency of tumors as well as the number of cases of multicentered growth of neoplasm in both irradiated and non-irradiated females is higher than in the male. The high frequency of neoplasms in females is explained by the preeminent origin in them of tumors of the mammary gland, pituitary gland, ovaries, and polyps of the uterus. After irradiation at doses of 59 to 600 rad in female rats, not only the frequency but also the speed of development of tumors of the mammary glands increase. In control rats tumors of the mammary gland were detected over 12 months and in irradiated over 7 months. A marked increase of the frequency of leukocytosis in male and female rats was noticed after irradiation at doses of 200 to 400 rad (with 1.7% in controls up to 11.4%). Doses, doubling spontaneously the frequency of leukocytosis in rats, are equal to 50 rad. The maximum frequency of tumors of the pituitary gland in females (34.3%) was detected after irradiation with 200 rad and in males (42%) at doses of 50 rad. Then with increase of the dose, the frequency of tumors of the pituitary gland in males and females decreases. The frequency of tumors of the suprarenal in rats increases with irradiation at doses of 100 rad and higher, of the thyroid gland at doses of 25 to 50 rad, of the kidney at doses of 600 rad, and of the gastro-intestinal tract at doses of 100 to 600 rad. (tr-auth)

13050 BIOLOGICAL ACTION OF 240-MeV PROTONS. Moskalev, Yu. I.; Petrovich, I. K. Radiobiologiya, 6: 651-9 (1966). (In Russian).

The LD_{50} of 240-MeV protons for 7, 15, 30, 60, 120, 240, 360, and 480 days was 776 ± 44, 736 ± 26, 675 ± 33, 675 ± 26, 645 ± 32, 631, ± 32, 628 ± 30, and 519 ± 28 rads, respectively. The irradiation with 240-MeV protons causes leukopenia within 3 to 14 days with reduction of the number of leukocytes over 1 to 2 months and with development of neutrophils over 16 to 18 months after irradiation. Erythropenia is noticed only for high doses of protons. Irradiation with 240-MeV protons significantly increases the frequency and velocity of the formation of tumors of the mammary gland of female rats of the Wistar line. (tr-auth)

13051 ACUTE PROMYELOCYTIC LEUKEMIA APPEARING 17 YEARS AFTER A CAROTID ARTERIOGRAPHY WITH THOROTRAST. Bernard, Jean; Boiron, M.; Guerin, R.-A.; Gerard-Marchant, R.; Ripault, J.; Moulias, R.; Delaport, P. (Hopital Saint-Louis, Paris). Presse Med., 74: 487-90(Feb. 23, 1966). (In French).

The case history of a 36-yr-old man, who was found to have leukemia as well as a markedly radioactive spleen, is reported. Gamma spectrography revealed that the radioactivity originated from Th. The patient had undergone carotid arteriography 17 yr earlier with the use of Thorotrast. When examined in 1964 the patient was found to have a normal blood picture except for a low white count ($1800/mm^3$). Later, acute promyelocytic leukemia was detected that was accompanied by excessive numbers of promyelocytes in the bone marrow and fibrinopenia. After a short remission, a rapidly fatal course ensued. Radiography revealed deposits of ThO_2 in spleen, liver, and mesenteric lymph nodes. Post mortem studies of these organs showed fibrosis and confirmed the presence of ThO_2 particles. No ThO_2 particles could be found in bone marrow. Autoradiography of liver and spleen demonstrated alpha particle emission in these tissues, and gamma spectrometry revealed peaks that were attributed to natural ^{40}K, fallout ^{137}Cs, and ^{228}Th. Spleen tissue was found to be radioactive to the extent of 1180 disintegrations per min per g. The carcinogenic and leukemogenic actions of Thorotrast are discussed. (BBB)

13052 REPRODUCTIVE AND IMMUNOLOGICAL CHARACTERISTICS OF A STRAIN OF AEDES AEGYPTI SELECTED FOR RESISTANCE TO GAMMA RADIATION. Stahler, Nathan; Terzian, Levon A. (Naval Medical Research Inst., Bethesda, Md.). Ann. Entomol. Soc. Amer., 59: 763-5(July 1966).

A strain of A. aegypti resistant to γ radiation was selected after exposure of the eggs of each generation to 2500 R. It showed significantly greater pupation and adult eclosion rates than the parent (NMRI) strain from which it was derived when the eggs of both were exposed to 2000 R. Studies of the selected strain with reference to sexual compatibility with the parent stock, rate of oviposition, susceptibility to malarial infection, and reversion after relaxation of selection pressure are reported. (BBB)

13053 PROLONGATION OF RENAL HOMOGRAFT SURVIVAL BY INHIBITION OF THE AFFERENT ARC OF THE IMMUNE RESPONSE. Cleveland, Richard J.; Kauffman, H. Myron; Graham, Walter H.; Hume, David M. Surg. Forum, 16: 269-71(1965).

Selective suppression of the immune response to renal homografts by local irradiation of the graft does not cause leukopenia or indiscriminate impairment of immune system function. In an attempt to demonstrate the mechanism of action of both local graft irradiation and chemotherapy with azathioprine, the effect of treatment of the first-set kidney graft was assayed by placing untreated second-set grafts from the same donor. Therefore, any prolongation of functional survival time (FST) of second-set grafts must be due to inhibition of the afferent arc of the immune response. Adult dogs received a renal homograft with a cutaneous ureterostomy and 6 daily x-ray doses of 150 R, the first dose being administered on the day of transplantation. Radiation to the transplant was given from a 2000-kvp machine at a rate of 100 R/min. Azathioprine-treated animals received a dose of 5 mg/kg. First-set grafts were allowed to remain in the host for 4 to 6 days in controls, 4 to 8 days in local graft radiation animals, and 4 to 19 days in azathioprine-treated animals. After first-set grafts were removed, second-set grafts were placed immediately, or after a test period of 4 to 20 days. Functional survival time of second-set grafts was assessed by urine production. The mean FST of control second-set grafts was 1.9 days. The mean FST of second-set grafts in animals which received local radiation to the first-set graft was 3.4 days. While not as long as the mean FST of untreated first-set grafts (5.6 days), it was significantly prolonged. The mean FST of second-set grafts after azathioprine treatment of the first-set graft was 4.2 days. The functional survival time data and altered second-set histology indicated that both local graft irradiation and azathioprine inhibited the afferent arc of the immune response. This was probably not due to alteration of antigenicity of the graft as 1500 R to the donor kidney immediately prior to transplantation does not prolong graft survival time. It is postulated that local graft irradiation interferes with cells which pick up and transport antigen from the graft to the antibody-producing centers of the host. (BBB)

13054 IS INSUFFICIENT NOURISHMENT IN RADIATION DISEASE THE MAIN CAUSE OF MALIGNANCY IN TRAUMA OF THE JAWS? Sicha, Vladimir (Charles Univ., Hradec Kralove, Czech.). Cesk. Stomatol., 65: 453-7(Nov. 1965). (In Czech).

It was found that leg or jaw fractures in rats exposed to 450- or 600-R doses of x rays increased the lethality of the radiation syndrome. Fractures of the mandible were found to aggravate radiation disease to a greater extent than thigh fractures in rats. Attempts were made to ascertain whether difficulties in eating and consequent nutritional impairment could be responsible for the severe effect of jaw injury in irradiated rats. Rats of the Wistar strain weighing 182 g were submitted to 600-R, whole-body doses of 180-kv x rays and to fractures of the thigh or jaw bone. Another group of rats was x irradiated and fed less food than that consumed by the irradiated rats with fractures. The results indicated that aggravation of the radiation syndrome by mandibular fracture could not be attributed to inanition because of oral trauma. Irradiated rats under dietary restriction greater than that of jaw-fractured irradiated rats survived longer and failed to lose weight as compared with the latter rats. (BBB)

13055 PRENATAL THERAPEUTIC RADIATION: PRELIMINARY REPORT OF TWO CASES. Degering, Charles I. (Univ. of Washington, Seattle). Oral Surg., Oral Med., Oral Pathol., 21: 473-7(Apr. 1966).

A case study of a female patient who received abdominal irradiation of the ovaries in excess of the 30-yr max permissible dose of 10 R to genetic tissue, and who subsequently gave birth to two children with dental anomalies is reported. The 20-year-old woman underwent radiotherapy for malignant lymphoma; technical details are outlined. From June 1957 to July 1960, 900 R of abdominal irradiation (200-kv x rays) was given. Two children were born during this period, but neither was irradiated in utero. Physical dissimilarities of the patient's two children and their histories of development are compared. The clinical appearance of the dentitions of the two children is illustrated. Bitewing and apical roentgenograms of the anomalies of the dentition were taken; apical films are presented. From the original roentgenogram of case 1, it appeared that a supernumerary tooth developed in the maxillary midline. Oral examination of Case 1 revealed normal soft tissues, prominent cusp formation, and supernumerary maxillary right deciduous lateral incisor. In Case 2, the following were observed: enlarged tonsils, hyperplasia of palatal vault, prominent palatal mucous glands, prominent cusp formation, yellowish hue to dentition, and geminated right mandibular lateral incisor-cuspid. Whether the anomalies reported represent natural mutations or induced mutations is open to question. (BBB)

13056 PHOTOTOXICITY OF SHALIMAR PERFUME. Burdick, Kenneth H. (Dartmouth Medical School, Hanover, N. H.). Arch. Dermatol., 93: 424-5(Apr. 1965).

Skin denuded of stratum corneum was treated with undiluted Shalimar perfume and then irradiated with uv light for 10 min; intense phototoxic reactions occurred in all subjects tested (4 males and 6 females). Darkening of the skin (Meirowsky effect) occurred 15 min after treatment. After 24 hr, the denuded and treated area on all ten persons showed erythema; control areas were unchanged in appearance. At 48 hr, intense erythema and vesiculation had appeared in the treated areas. The phototoxic reaction reached a peak at ~72 hr and then subsided with variable amounts of pigmentation remaining; the amount of pigmentation was less in individuals displaying the most intense vesiculation. An examination of Shalimar perfume with a spectrophotofluorometer produced strong emission and activation peaks of the furocoumarin pattern and indicated that this material was the potent phototoxic agent in the perfume. (TSS)

Radiation Effects on Plants

Refer also to abstracts 12693, 12792, 12815, 12817, 12823, 12824, 12872, 13016, 13018, and 13363.

13057 (STI-DOC-10/64) EFFECTS OF LOW DOSES OF RADIATION ON CROP PLANTS. Technical Reports Series No. 64. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1966. 65p. IAEA: $1.50; Austrian Schillings 39,-; 10/7 std; F Fr 7,40; DM 6,-.

Experimental results of studies on radioinduced growth stimulation in plants are reviewed and evaluated, and the significance of

such investigations with respect to practical applications for increasing crop yields are discussed. Increased growth (growth stimulation) was observed in several plant species, and the effects of radiation varied with the plant species and variety. In addition to an increase in plant length, improved root growth development was also found in many cases. It was the general opinion that the effects of small doses of ionizing radiations may be caused by shortening of seed dormancy. Thus, the stimulation effects could always be demonstrated on seed samples with reduced germination vitality and germinative capacity and faculty. The magnitude of the germination and growth increase amounted to 10 to 40% and varied considerably with different experimental conditions. After treatments of seeds with such small doses of ionizing radiation it was impossible to find any morphological changes. No changes in cell size or chromosome aberrations were found. Increased growth was repeatedly demonstrated in growing plants exposed to chronic radiation exposures. The most surprising observation in some experiments by various investigators is that a positive effect has been demonstrated in successive years (three years without new irradiation-treatment in each generation). Statistically significant effects have been found in the seedling growth of cereals and the yield of potatoes. The improvement of yield by irradiation is dependent on the radiation dose and the prevailing or existing environmental conditions, as well as the species or variety of the crop plant. Yield increases of 2 to 10% were obtained in several cases over successive years. Obviously, the observed radiation effects on germination, seedling growth, and yield, must be caused by various changes in the metabolism of the cells. Various hypotheses to explain this effect were suggested and discussed. It is clearly demonstrated that it is possible to obtain stimulation effects on plant growth and on crop yield in some cases. But this effect has only been found in certain species (i.e., wheat, potatoes) and depends on various factors, such as seed quality, and different environmental conditions. The discussion did not reveal any special factors that would have had a conclusive influence on the effect. Considering the different hypotheses, it should be stressed that not only one mechanism would be changed by irradiation; there are always several reactions, which can be chemical and physical effects. Very low doses (20 mR) may cause an increase of plasmatic viscosity, or it might also be possible that the auxin and hormones syntheses are influenced by radiation. It is suggested that radiation with low doses might influence enzymatic systems, and, therefore, phosphorylation. (H.G.D.)

13058 COMPARISON OF THE EFFECT OF CHEMICAL COMPOUNDS AND SMALL DOSES OF IRRADIATION ON PLANT METABOLISM. Flaig, Wolfgang; Schmid, Gustav (Forschungsanstalt fuer Landwirtschaft, Brunswick). Landbauforsch. Voelkenrode, 15: 53-62(1965). (In German).

A review, with 89 references, is presented which surveys the similarities between certain chemical stimulants and low-dose irradiation in increasing plant metabolism. The action of physiologically active substances as well as ionizing radiation may increase the germination time of seeds, the height and dry weight of seedlings; also, depending upon environmental conditions, the yield of the plants may be increased. The increased formation of plant material by the effect of physiologically active substances can be explained by a weak uncoupling of oxidative phosphorylation, as experiments with cell fractions have demonstrated. Irradiation with low doses of ionizing radiation causes alterations in the metabolism of seeds, seedlings, and cell components which are comparable with those effected by physiologically active substances. Previously reported results are cited which indicate that ionizing irradiation may lead to formation of certain compounds which may act as growth stimulants. Some of these compounds appear to be identical with physiologically active substances. Thus low-dose irradiation has been found to increase the in vitro formation of indoleacetic acid from tryptophan. (BBB)

13059 HOW DO PLANT EMBRYOS REACT TO RADIATION INJURIES. Haccius, Barbara (Univ., Mainz). Umschau, 65: 295-8(May 15, 1965). (In German).

Development of seeds was studied in x-irradiated cultures of Eranthis hiemalis. After irradiation with 1000 or 1500 R most of the cells survived, but after irradiation with 2000 R cell survival was less. However, most of the surviving cells were malformed. The numbers of cotyledons varied considerably, many were deformed and appeared as twins and multiples of all types. Similar results were observed in studies with Urtica urens, Lepidum sativum, and Ranunculus. Within two months following irradiation, cell division was still absent, but by three months after exposure some cells had a normal appearance and cell division could be observed. Subsequently the seeds developed more and more into normal appearing embryos. The results indicated that several cells within the embryo had the potentiality to develop into normal embryos, and that their isolation by irradiation may have been a precondition for realization of their developmental capacities. In addition, the amounts of irradiation probably were not great enough to cause complete destruction of the original cell structure. (BBB)

13060 ON THE INDUCTION OF EXTRAMUTATIONAL RADIATION EFFECTS IN CLONAL VARIETIES OF EUPHORBIA PULCHERRIMA WILLD. Poetsch, Joachim (Botanisches Inst. der Paedagogischen Hochschule, Potsdam, Ger.). Zuechter, 36: 12-24(Apr. 15, 1966). (In German).

Rooted cuttings of the periclimal chimeras E. pulcherrima, "Eckes Pink" and "Trebstii alba," and the homohistic clones "Imperator" and "Eckes White" were x irradiated with from 500 to 4000 R. The LD_{50} of single clones was between 3000 and 4000 R. The primary effects increased directly with increasing dosage. These included light green coloration of the blade base after 2000 to 3000 R, blade deformations of all kinds, reduction of blade parts, lauciform outgrowth of the leaf margin, and bifurcation of the central leaf rib, green mosaic of the leaf blades due to loss of palisade cells, intercellular enlargement, giant cell formation, and destruction of chloroplasts in the mesophyll. Leaf succulence was increased by an increase of cell layers of the spongy parenchyma and enlargement of mesophyll cells and intercellular spaces. With low doses of radiation growth was stimulated, but after 2000 to 3000 R it was depressed. All morphoses observed after irradiation were temporary and were found on organs directly damaged. Perforations and reduplications appeared after damage or destruction of shoot apex tissues to primordial leaves, and were followed by rearrangement or dissociation of the chimeras during further histogenesis of the irradiated apices. These were observed at all levels of irradiation, and increased in frequency and surface area in proportion to the irradiation received. Radioinduced color changes were not always based on newly occurring somatic mutations, but could be traced to rearrangement or dissociation in the chimeric clones. Genetic and histogenetic effects of x irradiation were differentiated. Monectochimera WRR produced diectochimera "Trebstii alba," and the homohistonts "Imperator" and "Ecke's White." Diectochimera WWR produced monectochimera "Ecke's pink" and homohistonts "Imperator" and "Ecke's White." References cited, 59. (BBB)

13061 MITOCHONDRIAL RESISTANCE TO MASSIVE IRRADIATION IN VIVO. I. STRUCTURAL STABILITY AS EVIDENCED BY ELECTRON MICROSCOPY, MEMBRANE FUNCTIONS, AND FATTY ACID COMPOSITION. Romani, R. J.; Fisher, L. K.; Miller, L. A.; Breidenbach, R. W. (Univ. of California, Davis). Contract AT(11-1)-34. Radiat. Bot., 7: 41-5 (Feb. 1967). (UCD-34P112-23).

Mitochondria were isolated from fruit (cherries and pears) that had absorbed from 250 to 1000 Krad of ionizing radiation. A lack of obvious structural damage or changes in some membrane characteristics suggest a marked radioresistance of the mitochondria. (UK)

13062 GAMMA-RAY-INDUCED ESR SIGNALS IN LETTUCE: EVIDENCE FOR SEED-HYDRATION-RESISTANT AND -SENSITIVE FREE RADICALS. Haber, A. H.; Randolph, M. L. (Oak Ridge National Lab., Tenn.). Radiat. Bot., 7: 17-28(Feb. 1967).

The effects of wetting and redrying lettuce seeds on γ-radiation-induced electron-spin-resonance (ESR) signals were studied. Seeds were wetted and then dried at room temperature over a desiccant, followed by equilibration in the atmosphere until the water content for both the wetted-redried seeds and their unwetted controls was approximately 6 to 7 percent. When γ-irradiated seeds were completely wetted and redried, most, but not all, of the radiation-induced signal was eliminated. The radiation-induced signal that persisted after wetting and redrying was approximately 8 percent of the total radiation-induced signal in unwetted seeds. The derivative curve of the signal from unirradiated seeds, both before and after wetting and redrying, had a peak-to-peak line width of 6.5 G. The corresponding line width of the radiation-induced signal for doses less than 1 Mrad was not detectably different from the endogenous signal width. At very high doses (5 to 20 Mrad), the radiation-induced, water-resistant signal was from 4 to 12 percent wider and the radiation-induced signal in unwetted seeds was from 9 to 20 percent wider. No difference in G values (2.006 to 2.007) were detected resulting either from irradiation or from wetting and redrying. Studies of power saturation, however, did indicate a difference between the radiation-induced resonances that persisted after wetting and redrying vs the radiation-induced resonances that were present in unwetted controls. The results indicate a difference in the molecular environment of such radiation-induced unpaired electrons that persist after hydration vs the molecular environment of radiation-induced unpaired electrons in unwetted seeds. Reirradiation of seeds that had been wetted and redried after receiving 8 Mrad was as effective in inducing resonances as was irradiation of control seeds that were not irradiated before

being wetted and redried. This indicates that the radiation-induced resonances that persist after hydration and redrying do not influence the subsequent induction of resonances by radiation. This last finding also suggests that the radiation-induced signal that disappears on seed hydration can be reversibly eliminated by hydration and reinduced by reirradiation. (auth)

13063 EFFECT OF ETHYL METHANESULFONATE ON THE FERTILITY OF BARLEY. Sato, M.; Gaul, H. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). Radiat. Bot., 7: 7-15(Feb. 1967).

The effect of ethyl methanesulfonate (EMS) on the fertility of barley was cytologically and genetically studied. The fertility of the M_1 generation of seeds treated with 3% EMS at 24°C for 3 hr was reduced to 20.8 percent seed setting. In the cytological study of root-tips from seeds treated with 2, 3, and 4% EMS, the percentage of abnormal anaphases at the first mitotic cycle was 30.1, 45.5, and 61.7 percent, respectively, whereas 30,000 R of x rays resulted in 23.0 percent. The relative ratio of bridges to fragments produced by EMS was considerably lower than that of x rays. An effect of EMS on cell division, which was similar to that of colchicine was found after seed treatment with 3 and 4% EMS. The percentage of M_1 spikes with chromosomal re-arrangements after seed treatment with 3% EMS was only 3 percent, which coincided with the frequency of double bridges in the root-tip study. Other anomalies in M_1 meiosis were also observed, such as dissynchronization of the stages of PMCs, actively dividing tapetal cells during pachytene or even metaphase, extreme stickiness of chromosomes, tetrad cells without nucleus and abnormal form of tetrads. Genetic studies were carried out up to M_4 generation in order to gain insight into the pattern of inheritance of sterility. The studies reveal that the sterility induced is heritable. The modes of segregation suggest that the heritable change occurs in the nucleus rather than in the cytoplasm. The studies also suggest that, in contrast to the effects of x-rays, a large part of sterility has a diplontic and not a haplontic nature. It is assumed that small invisible deficiencies are the main cause of sterility. (auth)

13064 MITOCHONDRIAL RESISTANCE TO MASSIVE IRRADIATION IN VIVO. II. DENSITY-GRADIENT DISTRIBUTION OF THE MITOCHONDRIAL FRACTION AND ASSOCIATED ENZYMES. Miller, L. A.; Prasad, R.; Romani, R. J. (Univ. of California, Davis). Contract AT(11-1)-34. Radiat. Bot., 7: 47-54(Feb. 1967). (UCD-34P112-24).

Sucrose density gradient centrifugation was utilized to discern effects of massive γ irradiation (250 and 1000 Krad) on the mitochondrial fraction in pear fruit cells. Protein content and three enzymes, cytochrome oxidase, catalase and acid phosphatase were used to detect the presence of specific organelles along the sucrose gradient. A dose of 250 Krad deterred mitochondrial fragmentation and losses in enzyme activities known to occur in the unirradiated, aging control cells. A 1000-Krad dose, however, produced obvious manifestations of massive stress to the fruit and augmented the degenerative processes associated with cellular aging. (auth)

13065 INFLUENCES OF CULTURE TEMPERATURE ON THE X-RAY SENSITIVITY OF BARLEY ROOTS. Kiefer, J. (Inst. of Biophysics, Giessen, Ger.). Radiat. Bot., 7: 55-65(Feb. 1967).

The effects of different temperature treatments on the radiation damage in barley roots are described. Culture temperatures were varied before and after irradiation. It was found that the nutrient supply from the seed plays an important role in the restitution processes and is the limiting factor with higher culture temperatures. The pattern of temperature effects is complex and different from that found in animal systems. (auth)

13066 INTERACTION OF RADIATION AND PHOTOPERIODISM IN XANTHIUM PENSYLVANICUM. EFFECTS OF RADIATION DURING THE LIGHT AND DARK PERIODS OF PHOTOINDUCTION. Brown, G. N.; Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Radiat. Bot., 7: 67-72 (Feb. 1967). (ORNL-P-2316).

Two groups of Xanthium pensylvánicum plants received a dose of 1927 rad ^{60}Co γ radiation during either the dark or light period of short day photoinduction. Another group of plants was photoinduced but not irradiated. Vegetative growth was initially stimulated in both groups of irradiated plants, but later responses were not observed. Both pistillate and staminate flowering were inhibited in both groups of irradiated plants, but pistillate flowering was inhibited to a greater extent. Staminate and pistillate development was retarded in both groups of irradiated plants, with the greatest inhibition occurring in plants irradiated during the light period. Results are interpreted as responses to radiation-induced changes in nucleic acid and growth hormone metabolism. (auth)

13067 STUDIES ON RADIATION-INDUCED FRAGMENTS AND STRUCTURAL REARRANGEMENT OF CHROMOSOMES IN CORIANDRUM SATIVUM. Joshi, Sheila; Raghuvanshi, S. S. (Univ. of Lucknow, India). Curr. Sci. (India), 36: 79-80(Feb. 5, 1967).

Seeds of Coriandrum sativum were irradiated at various doses from 5,000 to 30,000 R. The percentage of germination decreased with increasing doses. Morphological changes in the plants grown from the irradiated seeds are described. Chromosome aberrations and mitotic abnormalities of these plants are also described. Another feature of interest was the presence of abnormal pollen grains. However, the frequency of these was low compared with that of colchicine-gammexane treated plants. (H.L.W.)

13068 EFFECT OF IONIZING RADIATION ON THE YIELD AND QUALITY OF SUGAR BEET AND POTATO. Zhunusov, R. S. Vestn. Sel'skokhoz. Nauki, Min. Sel'sk. Khoz. SSSR, 10: No. 2, 32-4(1965). (In Russian).

Radiation affects the intensity of carbohydrate synthesis in sugar beets and potatoes. Irradiation of potatoes during the period of tuber formation increased the starch content of the tubers without increasing yield. Developmental processes are more radiosensitive than others. Young plants are reported to react negatively to irradiation. (HGD)

13069 THE RADIOSENSITIVITY OF SEEDS OF ENGLISH TYPE PASTURE R.v.P. RAY GRASS AT DIFFERENT MOISTURE LEVELS IN RELATION TO HEAT TREATMENT. De Loose, R. (Station de Recherches de l'Etat pour l'Amelioration des Plantes de Grande Culture, Lemberge, Belg.). Rev. Agr. (Brussels), 16: 977-84(June 1963). (In French).

The effect of pretreatment with heat (30 min at 75°C) on the radiosensitivity of seeds stored at 0 to 95% relative humidity was examined. Such heat treatment decreased the radiosensitivity of seeds at low humidities (0 to 9%) exposed to 12,000 to 24,000 R of x rays. In contrast, heating seeds at relative humidities of 65% before irradiation (32,000 R) increased radiosensitivity. The seeds were irradiated in sealed polyethylene vials. Heat treatment in the absence of irradiation did not affect viability of seeds stored at 0 to 20% relative humidity, diminished viability of seeds at 65 to 95%, and was lethal to seeds at 95 to 100% relative humidity. In experiments in which heating to 75°C was carried out for 10 min rather than 30 min, seeds at 90 to 100% relative humidity were not affected by heating per se but their radiosensitivity was increased. In contrast, under the same conditions radiosensitivity of seeds stored at 0 to 20% relative humidity was decreased. With seeds at 65% humidity, 10-min heating at 75°C did not affect radiosensitivity. (BBB)

13070 EFFECT OF X-IRRADIATION ON YIELD IN BARLEY. Loiselle, R. (Genetics and Plant Breeding Research Inst., Ottawa). Cereal News, 9: 17-20(Spring 1964).

An experiment was performed to determine the effects of x rays on yield of normal-appearing plants following irradiation of Parkland variety barley. Five hundred seeds (air-dried) from each of 10 lines selected at random from a block of space-planted breeder seed were treated with 10,000 R. The irradiated seeds (X_1) were immediately space-planted in the field. Only normal-appearing plants from each irradiated line were harvested. The X_2 lines were compared for seed yield with nonirradiated material in 1960. The X_3 lines were compared with their nonirradiated counterparts and with nonirradiated seeds in 1961. Average yields in grams per plot for the irradiated lines, their nonirradiated counterparts, and Parkland are shown. The differences between the X_2 lines and between them and Parkland were not significant in 1960. The same was true in 1961 for the differences between the X_3 lines, between the nonirradiated lines, between the irradiated lines, their nonirradiated counterparts, and Parkland. These results differ from those reported previously for peanuts and peas, in which increased yields were obtained in normal-appearing plants following irradiation. It is pointed out that mutation experiments are generally carried out with high-yielding varieties of cultivated crops and therefore improved forms should not be expected to arise in great quantity. This explains largely why no high-yielding lines could be isolated from Parkland, which is a very productive barley variety. In pea experiment, where mutants with increased yields were obtained, the original variety had a low yielding capacity. (BBB)

13071 THE EFFECT OF β-RADIATION ON MICROORGANISMS. II. STREPTOCOCCUS FAECALIS (LANCEFIELD GROUP D). Szilvinyi, A. v.; Frimmel, F. (Hochschule fuer Bodenkultur, Vienna). Atompraxis, 12: 512-16(Oct. 1966). (In German).

The effect of β-radiation (^{90}Sr + ^{90}Y) on four strains of Streptococcus faecalis Andr. et Hord isolated from deep-freeze spinach, is investigated. Reproductions of growth-, survival-, sensitivity and regression-curves show that this bacterium is heterogeneous in various growth phases with regard to radiation sensitivity. But populations produced uniformly in the logarithmic growth-phase by a chemostat-culture have homogeneous radiosensitivity. In this

phase they are most resistant, their LD_{50} having been defined at 48.9–67.6–93.4 krad (95% range of validity). The corresponding values of a bulk cuture in a logarithmic growth-phase are 17.8–20.4–23.4 krad. The significance of heterogeneous radiation sensitivity in radiation microbiology is stressed. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 12693, 12756, 12794, 12797, 12825, 12874, 13018, and 13093.

13072 (COO-1117-10) MECHANISMS OF LETHAL RADIATION DAMAGE AND RECOVERY IN ALGAL FLAGELLATES. Final Scientific Report. Jacobson, Baruch S. (Minnesota Univ., Minneapolis). [1966]. Contract AT(11-1)-1117. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Chlamydomonas reinhardi and Chlorella ellipsoidea reproduce through mitotic cycles characterized by a long growth period followed by 2 or more divisions in rapid succession. At least 4 daughters are produced per division cycle. In both algae, gamma irradiation from ^{137}Cs or plating on actinomycin D (AMD) agar results in a blockage of the cycle in the single-cell stage. Most cells undergo a complete cycle before this occurs. Colonies growing on dithiodiglycol agar are frequently arrested in the 2-cell stage. The incorporation of inorganic phosphate into Chlamydomonas DNA is not inhibited by irradiation or by AMD. Incorporation of ^{14}C into DNA from CO_2 was increased in the presence of AMD. Labelling of protein was relatively unaffected. The rate of incorporation of ^{14}C into RNA was correlated with the cell count, which increased most rapidly in the controls. Under the conditions tested, chloramphenicol, which produces a similar mitotic block, inhibited ^{14}C incorporation into all three fractions. The critical stage in the division cycle, at which effects of AMD, chloramphenicol or previously incurred radiation damage are expressed, is probably the period immediately prior to the first mitosis of the cycle. (auth)

13073 (UCRL-16898, pp 97-116) INTERPRETATION OF MICROBIAL INACTIVATION AND RECOVERY PHENOMENA. Haynes, Robert H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Reproductive death in bacteria treated with x rays, ultraviolet light, or nitrogen mustard arises primarily from the formation of structural defects in DNA serving to block normal DNA replication. In many cells, viability is enhanced through the action of certain enzymic processes that repair these defects before the onset of replication. Thus, in the analysis of dose-response curves, survival is determined jointly by the nature and distribution of the initial DNA defects and the probability of their subsequent repair. The apparent radiosensitivity of cells can be increased by altering either the physico-chemical reactions involved in the formation of the defects or by interfering with the biochemical repair processes. Sensitization by interference with repair appears to be involved in at least three well-known radiobiological effects: (a) the existence of shoulders on survival curves; (b) the synergistic interactions that occur among uv, x rays, and nitrogen mustard; and radiosensitization by agents that either bind or are incorporated into DNA (e.g., acridine dyes and halogenated base analogs respectively). Since repair is an enzymic, energy-requiring process, it can be attenuated by excessive DNA substrate damage, by direct attack on the repair enzymes, or by blockage of its energy supply. In general, it is difficult to distinguish among these three alternatives. Repair of uv damage in E. coli B/r is a multistep process involving nuclease excision of defective single-strand segments containing pyrimidine dimers, and a non-conservative mode of DNA replication which fills in the resulting gaps. Similarities in the relative sensitivities of E. coli B/r, B and B_{s-1} to uv and nitrogen mustard, the involvement of nucleases in repair, and the observation of repair replication after both uv and nitrogen mustard treatment lend strong support to the idea that it is not the damaged bases themselves that are recognized by the repair enzymes, but rather the associated secondary structural alternations in the phosphodiester backbone. Thus, repair might be of general biological significance in the maintenance of genetic stability by detecting and repairing a variety of possible distortions or defects in the Watson–Crick structure. The selective advantage arising from the possibility of repair inherent in the complementary structure of DNA might account for the ubiquity of double stranded nucleic acid molecules as the genetic material of living cells. (77 references.) (auth)

13074 (UCRL-16898, pp 117-22) INACTIVATION OF PHAGE α BY SINGLE-STRAND BREAKAGE. Freifelder, David (California Univ., Berkeley. Lawrence Radiation Lab.).

Bacillus megaterium phage α is more sensitive to x irradiation than a typical phage of its size containing double-stranded DNA. Double-strand breakage accounts for only a small part of the inactivation in contrast with many other phages. An ultracentrifuge assay was used to measure single-strand breakage in the DNA of the x-irradiated phages. The inactivating event is apparently a single-strand break. However, not all single-strand breaks are lethal. Two alternatives are possible: (1) a break is lethal only if it occurs in a particular strand or (2) only one strand can function in the cell, and this strand is selected at random. These alternatives cannot be distinguished by the present experiments. (auth)

13075 (UCRL-16898, pp 123-7) REPLICATION OF DNA DURING F'LAC TRANSFER. Freifelder, David (California Univ., Berkeley. Lawrence Radiation Lab.).

F'Lac is a DNA-containing (1) episomal element, which can be transferred from a male donor strain of the bacterium E. coli to a female recipient by conjugation. The mechanism by which this transfer occurs is not known. Suggested models for transfer are of three types: those for which DNA synthesis is unnecessary, those for which DNA synthesis accompanies transfer, and those for which DNA synthesis precedes transfer. In most investigations, the nature of the DNA transferred under normal conditions of DNA synthesis has been examined. The nature of the transferred DNA was studied in another way. If a thymine-requiring male transfers F'Lac in a medium containing 5-bromouracil deoxyriboside (BUDR) instead of thymine, the presence of BUDR in the transferred DNA can be detected by virtue of its sensitization to the effects of short or long wavelength ultraviolet irradiation. DNA transferred without replication would be resolved as a fraction of F'Lac recipients relatively resistant to the irradiation. Experiments are described that show that, in agreement with the results of others, the transferred DNA has been replicated prior to or during transfer. (auth)

13076 SYNCHRONIZED DIVIDING YEAST CELLS. II. ENZYME SYNTHESIS AFTER INHIBITION OF CELL DIVISION THROUGH X IRRADIATION. Eckstein, H.; Paduch, V.; Hilz, H. (Univ., Hamburg). Biochem. Z., 344: 435-45(1966). (In German).

The x irradiation of synchronized yeast cultures inhibits respiration and some other metabolic processes without depressing aerobic glycolysis. The synthesis of 3 enzymes of the Embden-Meyerhof pathway in synchronized yeast cells (Saccharomyces cerevisiae) occurs in a definite phase of the cell cycle, which roughly coincides with the synthetic (S) phase for DNA. In the same time interval a doubling of the rate of aerobic glycolysis takes place. Irradiation of synchronized cultures with 50,000 R of x rays, leading to a complete inhibition of cell division, retards the onset of enzyme doubling (hexokinase > glyceraldehyde-3-phosphate dehydrogenase > alcohol dehydrogenase), but only slightly depresses actual enzyme increase. This elongation of the generation time explains the apparent inhibition (about 20 to 30%) of enzyme synthesis in irradiated asynchronously growing cells. The results exclude a general and irreparable lesion of the DNA matrix by ionizing irradiation. They point again to the high sensitivity of events intimately connected with cell division. (BBB)

13077 THE RADIOSENSITIVITY OF ESCHERICHIA COLI B CULTURES. II. THE EFFECT OF TREATMENT BEFORE, DURING, AND AFTER THE IRRADIATION ON THE RADIOSENSITIVITY OF THE CELLS. Hernadi, F.; Nagy, Zs.; Kovacs, P.; Mucsi, O. (Medical Univ., Debrecen). Acta Microbiol., Acad. Sci. Hung., 13: 1-11(1966). (In German).

E. coli B cultures were irradiated under partial or total anoxic conditions just prior to or during irradiation with up to 6.4 KR of conventional x-ray or ^{60}Co radiation, at rates of 260 R/min or 3200 R/min. After irradiation the cultures were incubated in normal or minimal media, with or without chloramphenicol for periods of 12 hr. The radiosensitivity of cultures grown on minimal media before irradiation was greater, as measured by cell survival, than of cultures grown on complete media. The survival of cell suspensions after irradiation was increased by maintenance on the minimal media. This effect was favored by the supplementation of the minimal media with organic substances, such as yeast, peptone, and bone marrow. In addition, the unfavorable effects on survival that was associated with the use of the complete media could be improved by means of substances or conditions that inhibit metabolism, such as anoxia and preincubation with chloramphenicol. At the lower rate of dose administration, which was 260 R/min, an increase in the environmental temperature during irradiation produced an increase of the radiosensitivity. This was not observed at the higher rate of irradiation, which was 3200 R/min. The radiosensitivity of the cell suspensions was reduced by a factor of 2.4 by inducing anoxia during irradiation by streaming N_2 gas through the cultures. (BBB)

13078 BIOCHEMICAL AND IMMUNOLOGICAL ASPECTS OF THE EXCLUSION OF LAMBDA BY SUPERINFECTION WITH T4. Soller, Arthur; Epstein, H. T. (Brandeis Univ., Waltham, Mass.). Virology, 26: 715-26(Aug. 1965).

phase they are most resistant, their LD_{50} having been defined at 48.9–67.6–93.4 krad (95% range of validity). The corresponding values of a bulk cuture in a logarithmic growth-phase are 17.8–20.4–23.4 krad. The significance of heterogeneous radiation sensitivity in radiation microbiology is stressed. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 12693, 12756, 12794, 12797, 12825, 12874, 13018, and 13093.

13072 (COO-1117-10) MECHANISMS OF LETHAL RADIATION DAMAGE AND RECOVERY IN ALGAL FLAGELLATES. Final Scientific Report. Jacobson, Baruch S. (Minnesota Univ., Minneapolis). [1966]. Contract AT(11-1)-1117. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Chlamydomonas reinhardi and Chlorella ellipsoidea reproduce through mitotic cycles characterized by a long growth period followed by 2 or more divisions in rapid succession. At least 4 daughters are produced per division cycle. In both algae, gamma irradiation from ^{137}Cs or plating on actinomycin D (AMD) agar results in a blockage of the cycle in the single-cell stage. Most cells undergo a complete cycle before this occurs. Colonies growing on dithiodiglycol agar are frequently arrested in the 2-cell stage. The incorporation of inorganic phosphate into Chlamydomonas DNA is not inhibited by irradiation or by AMD. Incorporation of ^{14}C into DNA from CO_2 was increased in the presence of AMD. Labelling of protein was relatively unaffected. The rate of incorporation of ^{14}C into RNA was correlated with the cell count, which increased most rapidly in the controls. Under the conditions tested, chloramphenicol, which produces a similar mitotic block, inhibited ^{14}C incorporation into all three fractions. The critical stage in the division cycle, at which effects of AMD, chloramphenicol or previously incurred radiation damage are expressed, is probably the period immediately prior to the first mitosis of the cycle. (auth)

13073 (UCRL-16898, pp 97-116) INTERPRETATION OF MICROBIAL INACTIVATION AND RECOVERY PHENOMENA. Haynes, Robert H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Reproductive death in bacteria treated with x rays, ultraviolet light, or nitrogen mustard arises primarily from the formation of structural defects in DNA serving to block normal DNA replication. In many cells, viability is enhanced through the action of certain enzymic processes that repair these defects before the onset of replication. Thus, in the analysis of dose-response curves, survival is determined jointly by the nature and distribution of the initial DNA defects and the probability of their subsequent repair. The apparent radiosensitivity of cells can be increased by altering either the physico-chemical reactions involved in the formation of the defects or by interfering with the biochemical repair processes. Sensitization by interference with repair appears to be involved in at least three well-known radiobiological effects: (a) the existence of shoulders on survival curves; (b) the synergistic interactions that occur among uv, x rays, and nitrogen mustard; and radiosensitization by agents that either bind or are incorporated into DNA (e.g., acridine dyes and halogenated base analogs respectively). Since repair is an enzymic, energy-requiring process, it can be attenuated by excessive DNA substrate damage, by direct attack on the repair enzymes, or by blockage of its energy supply. In general, it is difficult to distinguish among these three alternatives. Repair of uv damage in E. coli B/r is a multistep process involving nuclease excision of defective single-strand segments containing pyrimidine dimers, and a non-conservative mode of DNA replication which fills in the resulting gaps. Similarities in the relative sensitivities of E. coli B/r, B and B_{s-1} to uv and nitrogen mustard, the involvement of nucleases in repair, and the observation of repair replication after both uv and nitrogen mustard treatment lend strong support to the idea that it is not the damaged bases themselves that are recognized by the repair enzymes, but rather the associated secondary structural alternations in the phosphodiester backbone. Thus, repair might be of general biological significance in the maintenance of genetic stability by detecting and repairing a variety of possible distortions or defects in the Watson–Crick structure. The selective advantage arising from the possibility of repair inherent in the complementary structure of DNA might account for the ubiquity of double stranded nucleic acid molecules as the genetic material of living cells. (77 references.) (auth)

13074 (UCRL-16898, pp 117-22) INACTIVATION OF PHAGE α BY SINGLE-STRAND BREAKAGE. Freifelder, David (California Univ., Berkeley. Lawrence Radiation Lab.).

Bacillus megaterium phage α is more sensitive to x irradiation than a typical phage of its size containing double-stranded DNA. Double-strand breakage accounts for only a small part of the inactivation in contrast with many other phages. An ultracentrifuge assay was used to measure single-strand breakage in the DNA of the x-irradiated phages. The inactivating event is apparently a single-strand break. However, not all single-strand breaks are lethal. Two alternatives are possible: (1) a break is lethal only if it occurs in a particular strand or (2) only one strand can function in the cell, and this strand is selected at random. These alternatives cannot be distinguished by the present experiments. (auth)

13075 (UCRL-16898, pp 123-7) REPLICATION OF DNA DURING F'LAC TRANSFER. Freifelder, David (California Univ., Berkeley. Lawrence Radiation Lab.).

F'Lac is a DNA-containing (1) episomal element, which can be transferred from a male donor strain of the bacterium E. coli to a female recipient by conjugation. The mechanism by which this transfer occurs is not known. Suggested models for transfer are of three types: those for which DNA synthesis is unnecessary, those for which DNA synthesis accompanies transfer, and those for which DNA synthesis precedes transfer. In most investigations, the nature of the DNA transferred under normal conditions of DNA synthesis has been examined. The nature of the transferred DNA was studied in another way. If a thymine-requiring male transfers F'Lac in a medium containing 5-bromouracil deoxyriboside (BUDR) instead of thymine, the presence of BUDR in the transferred DNA can be detected by virtue of its sensitization to the effects of short or long wavelength ultraviolet irradiation. DNA transferred without replication would be resolved as a fraction of F'Lac recipients relatively resistant to the irradiation. Experiments are described that show that, in agreement with the results of others, the transferred DNA has been replicated prior to or during transfer. (auth)

13076 SYNCHRONIZED DIVIDING YEAST CELLS. II. ENZYME SYNTHESIS AFTER INHIBITION OF CELL DIVISION THROUGH X IRRADIATION. Eckstein, H.; Paduch, V.; Hilz, H. (Univ., Hamburg). Biochem. Z., 344: 435-45(1966). (In German).

The x irradiation of synchronized yeast cultures inhibits respiration and some other metabolic processes without depressing aerobic glycolysis. The synthesis of 3 enzymes of the Embden-Meyerhof pathway in synchronized yeast cells (Saccharomyces cerevisiae) occurs in a definite phase of the cell cycle, which roughly coincides with the synthetic (S) phase for DNA. In the same time interval a doubling of the rate of aerobic glycolysis takes place. Irradiation of synchronized cultures with 50,000 R of x rays, leading to a complete inhibition of cell division, retards the onset of enzyme doubling (hexokinase > glyceraldehyde-3-phosphate dehydrogenase > alcohol dehydrogenase), but only slightly depresses actual enzyme increase. This elongation of the generation time explains the apparent inhibition (about 20 to 30%) of enzyme synthesis in irradiated asynchronously growing cells. The results exclude a general and irreparable lesion of the DNA matrix by ionizing irradiation. They point again to the high sensitivity of events intimately connected with cell division. (BBB)

13077 THE RADIOSENSITIVITY OF ESCHERICHIA COLI B CULTURES. II. THE EFFECT OF TREATMENT BEFORE, DURING, AND AFTER THE IRRADIATION ON THE RADIOSENSITIVITY OF THE CELLS. Hernadi, F.; Nagy, Zs.; Kovacs, P.; Mucsi, O. (Medical Univ., Debrecen). Acta Microbiol., Acad. Sci. Hung., 13: 1-11(1966). (In German).

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13078 BIOCHEMICAL AND IMMUNOLOGICAL ASPECTS OF THE EXCLUSION OF LAMBDA BY SUPERINFECTION WITH T4. Soller, Arthur; Epstein, H. T. (Brandeis Univ., Waltham, Mass.). Virology, 26: 715-26(Aug. 1965).

Unrelated phages infecting the same cell are usually mutually exclusive. An earlier study of DNA, RNA, and protein synthesis after uv induction of lambda lysogens showed that the amount of DNA subsequently found in phage particles was approximately equal to the net amount of DNA synthesis so that host cell DNA synthesis appears to be shut off. The observed delay in net DNA synthesis was shown to be due to the uv itself since a similar delay was found in nonlysogenic cells. This report extends the study of mutual exclusion in the lambda system. The uv induction of Escherichia coli W (λ) under conditions described was characterized by a doubling of DNA and total protein before lysis and liberation of lambda phage. Superinfection by T4r$^+$ or T4rII resulted in the exclusion of lambda from the yield of most cells of induced W (λ). After rII superinfection there is just enough DNA made to account for the T4 DNA synthesized plus that amount attributable to the remaining lambda-producing cells. A proportionate decrease in total protein synthesis was also found in such cells. The lambda main C'-fixing antigen decreased in rough proportion to the amount of lambda phage produced in both the T4r$^+$ and T4rII superinfected cultures. In those cells not producing viable lambda, antigen equivalents were produced to account for not more than about 5% of the normal antigen yield. (BBB)

13079 ETIOLOGY OF LEUKEMIA. Gross, Ludwik (Veterans Administration Hospital, Bronx, N. Y.). Bull. Pol. Med. Sci. History, 8: 16-17; 23(Jan. 1966).

Induction of leukemia in animals, particularly by viruses and radiation-activated viruses, is reviewed. The leukemic virus, present in a latent form in normal, apparently healthy mice may be activated by total-body x irradiation. Filtrates prepared from such leukemic animals reproduced leukemia, following inoculation into newborn mice. It is apparent that leukemia in mice is caused by a transmissible and filterable virus. This virus can induce not only lymphatic, myeloid, or stem-cell leukemia but also other, less frequent forms such as chloroleukemia. The same virus can also induce lymphosarcomas and reticulum-cell sarcomas. The leukemic virus exists in many normal mice in a latent form. Electron microscopic studies reveal that the mouse leukemia virus is a small spherical particle approximately 100 mμ in dia which can be readily found in either cytoplasm of leukemic cells, or in intercellular spaces, in mice or rats with virus-induced leukemia. Large numbers of leukemic virus particles can be found in megakaryocytes in either bone marrow or in the spleen of animals with virus-induced leukemia. Leukemic viruses are transmitted naturally from one generation to another. It is possible that not only leukemic viruses, but also other tumor-inducing viruses, may be carried by many normal and perfectly healthy hosts. Trigger factors can be either external, such as radiation and certain chemical cell poisons, or internal, that is, of metabolic or hormonal origin. (BBB)

13080 THE PHOTODYNAMIC EFFECT OF VISIBLE LIGHT AND U.V. LIGHT ON PHAGE IN THE PRESENCE OF PHOTOSENSITIZING SUBSTANCES. Janovska, E.; Koudelka, J.; Kleinwaechter, V. (Biophysical Inst., Brno). Folia Microbiol. (Prague), 9: No. 3, 199(1964).

An investigation was made of the inactivation of phage T2 and kappa (Serratia marcescens) by visible and uv light in the presence of acridine orange (AO). The extent of photodynamic inactivation was determined by the diffusion of the dye into the phage heads and the subsequent reaction with DNA. After irradiation with visible light the phage was inactivated to a greater extent at pH 7 than at pH 5, in agreement with previous results with methylene blue. The permeability of the phage membrane was higher at pH 7 within certain temperature limits, in association with changes in the structure of phage protein. The rate of inactivation of phage at 40°C was 30 times greater than at 0°C. At lower temperatures the effect of pH on the rate of inactivation was also less; at 0°C the rate of inactivation at both pH values was the same. Incubation of phage with AO in the dark did not cause its inactivation, even after a prolonged time (24 hr) and at high concentrations of AO. However, the same experiment with dispersed daylight led to considerable inactivation of phage. It is evident that the reaction of DNA and AO alone does not cause inactivation; for this the absorption of visible light is necessary. Inactivation of phage by uv was also affected by the presence of AO. At pH 5 a higher rate of inactivation was found, although a smaller amount of AO penetrated into the phage. It is thus evident that the quantity of uv absorbed by the molecule of AO (the uv absorption maximum of AO is close to the maximum of nucleic acid) is not used for the inactivation of phage. The increased inactivation at pH 5 must be explained by another mechanism. (BBB)

13081 REACTIVATION OF UV RADIATION INJURIES OF COLIPHAGE T7. Ronto, Gyoergyi; Tarjan, Imre (Univ., Budapest). Strahlentherapie, 132: 143-8(Jan. 1967). (In German).

The inactivation of T7-phages by uv light of a Germicid-lamp was investigated using indicator host bacteria which were grown partly on caffeine containing culture media. The reactivation of the host cells was inhibited completely at a certain caffeine concentration (800 mg/100 ml of media). Using the dose effect curve, the probability for damaging an intact phage particle by the absorption of a uv-photon has been determined. A value of 2.5×10^{-4} was found. The probability for reactivating phages, which were damaged by a single hit, by the host bacteria was about 0.5. (auth)

13082 ULTRAVIOLET REACTIVATION OF A BACTERIOPHAGE CONTAINING A SINGLE-STRANDED DEOXYRIBONUCLEIC ACID AS A GENETIC ELEMENT. Ono, Joji; Shimazu, Yoshie (National Inst. of Radiological Sciences, Chiba, Japan). Virology, 29: 295-302(June 1966).

The uv reactivation (UVR) of bacteriophage φR, which contains single-stranded DNA, was studied using Escherichia coli C and E. coli Csyn$^-$ as host bacteria. E. coli C can perform host-cell reactivation (HCR) with uv-irradiated phage λ but is incompetent for HCR of φR. However, the UVR extent of φR in E. coli C was comparable with that found with phage λ. An induced enzyme hypothesis is proposed for the UVR property, although the mechanism for repair of uv lesions on the single-stranded DNA molecule during uv reactivation is still unknown. The possibility that the UVR enzyme and HCR enzyme are independent entities is also discussed. The survival of uv- or x-irradiated φR is increased with the phage infects host cells pretreated with uv or x rays. (BBB)

13083 DOSE-DEPENDENCE OF THE SEGREGATION PATTERN OF UV-INDUCED LETHALITY IN PEDIGREES DERIVED FROM PHASED SCHIZOSACCHAROMYCES POMBE. Haefner, K. (Southwest Center for Advanced Studies, Dallas). Photochem. Photobiol., 5: 587-90(July 1966).

The uv dose dependence of the frequencies of the different cell classes is given for a phased haploid S. pombe strain. About 600 pedigrees were analyzed after uv irradiation, and the frequencies of the four cell classes as a function of uv dose are shown. Phenomenologically speaking, a mechanism seems to be involved which rescues the primary lethally damaged cells by transfer of the damage to later generations. (TSS)

13084 COMPARISON OF THE RATE OF ULTRAVIOLET INACTIVATION OF THE CAPACITY OF TYPE 12 ADENOVIRUS TO INFECT CELLS AND TO INDUCE T ANTIGEN FORMATION. Gilead, Z.; Ginsberg, H. S. (Univ. of Pennsylvania, Philadelphia). J. Bacteriol., 92: 1853-4(Dec. 1966).

A new antigen has been found in cultures of mammalian cells infected with oncogenic adenovirus type 12 in which host and viral DNA synthesis is blocked by 5-fluorodeoxy uridine (FUDR). The antigen termed T (tumorlike) is immunologically similar to an antigen found in type 12 adenovirus induced tumors and in cells transformed in vitro. The antigen is distinct from viral structural proteins and it can be detected by complement fixation with sera of hamsters bearing virus induced tumors. In order to test the hypothesis that the information for production of T antigen resides in the viral genome, ultraviolet irradiation was employed. A comparison was made of the rate of inactivation of T antigen production with the rate of loss of infectivity (to KB cells) following ultraviolet irradiation. The results suggest that inactivation is due to viral DNA damage and that the target size of the viral genome locus for synthesis of T antigen is about one-fourth as large as that for viral synthesis. Other studies have been made that indicate that T antigen formation requires synthesis of RNA and protein. (TSS)

13085 RECOVERY FROM SUBLETHAL DAMAGE INDUCED BY X RAYS IN RELATION TO THE VARIATIONS OF RADIOSENSITIVITY DURING THE MITOTIC CYCLE IN SACCHAROMYCES CEREVISIAE. Bacchetti, S.; Cassandro, M.; Mauro, F. (Univ., Rome). Atti Ass. Genet. Ital., 11: 71-3(1966). (In Italian).

The x-radiosensitivity of a synchronized population of diploid yeast cells was determined during the first mitosis. Fluctuations in radiosensitivity during the first division cycle were compared to the survival variations during recovery of asynchronous and synchronous yeasts from fractionated doses. In synchronous populations radiosensitivity changes occurred only at termination of the recovery process, just before mitosis. Two recovery processes were identified (true recovery and radiosensitivity variations due to the progression of the cells toward division) and found to occur simultaneously in asynchronous populations. (H.G.D.)

13086 IONIZING RADIATION ACTION ON METABOLISM IN BACTERIA. Shekhtman, Ya. L.; Zanin, V. A. (Inst. Biological Physics, Moscow). Radiobiologiya, 6: 666-70(1966). (In Russian).

The effect of radiation on metabolic processes in cultures of intestinal bacilli was investigated. The metabolic processes studied

were absorption of oxygen, assimilation of glucose, increase of dry masses, synthesis of ATP, and activity of cytochrome system. It was shown that the metabolic processes are inhibited by doses greater than those necessary for suppression of the capacity of cells for multiplication. This indicates that there is not a direct relation between the disturbance of the metabolic process by irradiation and diseases of the system, responsible for cell multiplication. (tr-auth)

13087 THE MODIFICATION BY THIOUREA OF RADIATION INDUCED LETHAL DAMAGE IN DRIED SPORES OF BACILLUS MEGATERIUM. Biddulph, P. A. Manchester, Eng., Victoria Univ., 1966.

Thesis.

The object of the work described was to investigate the effect of thiourea (an agent known to protect against radiation lethal damage in bacteria in aqueous suspension) when included in freeze-dried spore/aluminium silicate powders. In particular, the extent to which this agent affects oxygen-dependent damage (both during and after irradiation) and oxygen-independent damage was studied. Bibliography 74 references. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 12557 and 12971.

13088 IONIZING RADIATIONS AND THE CONTROL OF TRICHINOSIS. Barriga, Omar O. (Univ., Chile, Santiago). Bol. Chil. Parasitol., 19: 89-92(July-Sept. 1964). (In Spanish).

Data relating to the use of ionizing radiation to eliminate trichinosis are reviewed, and feasibility and economics of use of this means to eradicate human and porcine infestation in Chile are considered. The human and porcine incidence of trichinosis in Chile is 12.5 and 0.37%, respectively. Irradiation of the larvae with doses of 5000 R results in sterile adult Trichinella spiralis. Pork can be treated with ^{60}Co γ radiation at doses of 30,000 rep to destroy the organism, and the use of this as a commercial process is examined. An irradiation plant with a ^{137}Cs source and a capacity for 2000 porcine carcasses per day is described. It would cost ~$566,000 (U.S.). The expense of irradiating pork would be ~$0.47 per 100 kg. (BBB)

13089 STERILIZATION OF MEDICAL SUPPLIES BY GAMMA RADIATION. Crawford, C. G. Med. Lab. (Stuttgart), 17: 112-16(May 1964). (In German).

Use of a large ^{60}Co source to sterilize disposable medical supplies is described. Disposable hypodermic syringes, catheters, surgical gloves, and other products are packed in impervious film envelopes that are completely sealed. These are then packed in cartons of a standard size to fit the sterilizing plant. The plant consists of a concrete cell that contains the ^{60}Co and arrangements for passing the cartons of medical products past the source. The cell has internal dimensions of 4.3 by 4.3m and the walls are 1.65 m thick. Cobalt-60, in the form of rods held in a vertical grid, is in its normal working position about 0.5 m above the floor. The source can be lowered into a concrete pit in the floor of the cell. (TSS)

13090 SUITABILITY OF FLEXIBLE PLASTICS AS PACKAGING MATERIALS FOR RADIOPASTEURIZED SEAFOODS. Tinker, Burton L.; Ronsivalli, Louis J.; Slavin, Joseph W. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Food Technol., 20: 122-4(Oct. 1966).

By sensory and physical tests, 18 commercially available flexible films were evaluated for packaging radiopasteurized fishery products. Fresh haddock fillets were irradiated with ^{60}Co γ rays at a dose of 250,000 rad and stored at 33 to 35°F. Representative samples of each lot were tested organoleptically immediately after irradiation and at intervals of 10 days, up to 30 days. The organoleptic quality of samples packaged in plastic pouches was compared with that of samples packaged in metal cans. Also obtained was information on some characteristics of each film, including seal efficiency, incidence of pinholes and other structural flaws, and effectiveness against bacterial penetration. A few of the films had high permeability to gas or were difficult to heat-seal. Polyethylene and polypropylene were not as suitable as some other materials for packaging irradiated fishery products. All samples packed in these materials were spoiled before the end of the 30-day storage period. The high rate of gas transmission of these materials apparently contributed to this faster rate of spoilage. Pouches of cellophane and rubber hydrochloride were relatively unreliable because many failed at the seals, which were not strong enough for normal handling. Most other flexible materials tested are suitable for packaging seafoods to be radiopasteurized and stored 1 month at 33 to 35°F. (BBB)

13091 EFFECT OF IRRADIATION ON THE PEELING OF NEWLY LAID EGGS HARD-COOKED FOLLOWING IRRADIATION. Fry, Jack L.; Herrick, George M.; Ahmed, E. M. (Univ. of Florida, Gainesville). Food Technol., 20: 131(Oct. 1966).

The change in peeling characteristics of hard-cooked eggs in which the albumen structure had been broken down by irradiation without significant pH increase was evaluated. Ten- and 100-Krad doses of ^{60}Co γ radiation were used. The Haugh units of eggs irradiated at 100 Krad were immediately reduced to 50% of their pretreatment level. Irradiation produced no immediate change in yolk pH but did result in some increase during storage. Albumen pH of the unstored irradiated eggs increased slightly but remained well below the level at which eggs are expected to peel easily. The pH levels after storage were significantly higher and were considered normal for eggs stored under the time and temperature conditions utilized. The ease of peeling control and irradiated eggs cooked immediately after irradiation did not significantly differ. Peeling losses were significantly greater than those of the stored eggs in which pH had risen naturally. The results indicate that peeling difficulty is not related directly to interior quality but is instead a function of pH. (BBB)

13092 RADIOISOTOPES USED IN PHARMACY. 2. STERILIZATION WITH IONIZING RADIATION. A SURVEY. Handler, J. A. (Royal Danish School of Pharmacy, Copenhagen). Dansk. Tidsskr. Farm., 35: 194-9(Oct. 1961). (In Danish).

A survey of the literature on the sterilization of pharmaceutical products with ionizing radiation is given. Merits of the theory of indirect action and the theory of direct action or the target theory are discussed. The sterilizing doses for different microorganisms are given, and measurements of the irradiation dose using electron accelerators and γ radiation from ^{60}Co and ^{137}Cs by means of different dosimeters, is also discussed. Some experiments on the effects of radiation, at a sterilizing dose, on a series of pharmaceutical products are reported. The conclusion is reached that the method will probably not be used in those instances where existing methods are satisfactory, but it will probably be used for hospital supplies and for such preparations as proteins, steroids, enzymes, and other substances for which existing methods of sterilization are unsatisfactory. Surgical sutures are satisfactorily sterilized with doses of 2 Mrad. (BBB)

13093 THE EXTENSION OF THE SHELF-LIFE OF POULTRY BY THE COMBINED APPLICATION OF TETRACYCLINE-1-DODECYL-4-BENZENE-SULFONIC ACID AND γ-RADIATION. Kiss, I.; Farkas, J. (l'Industrie Alimentaire, Budapest). Int. J. Appl. Radiat. Isotop., 18: 65-9(Jan. 1967). (In French).

The combined effect of immersion in a 20 mg/l tetracycline-1-dodecyl-4-benzenesulfonic acid solution and a γ ray treatment 100 to 200 Krads dose level was investigated. By treating the poultry with either the antibiotic or irradiation, its shelf-life could be increased two or threefold. When the antibiotic treatment was combined with irradiation at 100 Krads the keeping quality increased at least sixfold. Using the antibiotic and 200 Krads dose an eightfold increase could be achieved, as compared to that of the untreated control sample. The qualitative composition of the microbial population was also investigated, and the antibiotic and radioresistance of strains composing the majority of the population, as well as that of the psychrophil strains, was established. (auth)

13094 BIOLOGICAL EFFECTS OF IONIZING ^{60}Co RADIATION ON THE PREIMAGINAL STAGES OF MOSQUITO CULEX PIPIENS PIPIENS LINN. Kogai, E. S.; Kadyrova, M. K.; Shcherban, Z. P. (Inst. of Zoology and Parizetology, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz. SSR, No. 8, 44-6 (1966). (In Russian).

Data are presented on the biological effects of ionizing radiation on the development and survival of larva of Culex Pipiens Pipiens Linn mosquitoes and on the lethal and sublethal doses necessary for sterilization of male and female of the same species. The experiments demonstrated that sterilization of the male and female mosquitoes could be achieved by irradiation of eggs in late embryonic stage or larva in early development period with 1000 R. (R.V.J.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 12587, 13225, 13650, 13946, 13947, and 14081.

13095 (ORNL-3970) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1966. Peterson, Sigfred (comp. and ed.) (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 276p. Dep. mn. CFSTI $6.00 cy, $1.50 mn.

Research progress is reported in thirty-seven separate chapters grouped under the five following headings: fundamental programs, high-temperature materials, general fuels and materials, reactor development support, and other program activities. Abstracts were prepared for all the chapters. (D.L.C.)

For abstracts of individual chapters see: 12382, 12607, 13096–13100, 13108–13110, 13126–13128, 13153–13160, 13190, 13191, 13214, 13223–13227, 13240, 13260, 13619, 13982, 14058, 14086, 14087, and 14113.

13096 (ORNL-3970, pp 48-9) SUPERCONDUCTING MATERIALS. Picklesimer, M. L. (Oak Ridge National Lab., Tenn.).

The effects of metallurgical variables on the properties of metallurgical variables on the properties of superconducting materials are being studied. These variables include transformation products and morphologies, mechanical strain, aging reactions, and fabrication and heat-treatment procedures. Time-temperature-transformation curves for the transformation of the bcc solid-solution alloys of Nb and Zr to two bcc phases of different compositions at temperatures between 600 and 950°C were determined as functions of composition, temperature, and O_2 contamination. Critical current density measurements as functions of applied magnetic field on transformed specimens indicate that a broad maximum occurs between 40 and 60 vol % transformation, that is, when the grain boundaries are completely occupied by a pearlitic transformation product. The maximum critical current densities are greater by a factor of 10 to 15 than those obtained in severely cold-worked alloys. Electrical resistivity was measured on purified Tc at just above its critical temperature (7.8°K) and from 77 to 1700°K. Lattice and electronic thermal conductivities were calculated, and a Debye temperature of 411°K was obtained. Monoband interference filters producing monochromatic light were used to make black and white photomicrographs that show most of the information given by colors in microstructures anodized for color contrast. Several black and white photomicrographs are made of the same field in wavelengths of light selected to emphasize different features of the colored microstructure. These then allow presentation in technical journals of information derived from color without the prohibitive cost of color reproduction. (auth)

13097 (ORNL-3970, pp 61-80) HIGH-TEMPERATURE MATERIALS DEVELOPMENT. Harms, W. O. (Oak Ridge National Lab., Tenn.).

The capability for extrusion of W and W-base alloys was demonstrated, and floating-mandrel techniques obviating the use of glass-type lubricants were developed. A secondary fabrication method for production of thin-walled tubing by duplex extrusion with Mo jacketing was developed. Weldability studies were conducted on a variety of Nb- and Ta-base alloys, and mechanical properties of these welds were determined to 1300°C. Time-temperature parameters for aging and overaging were defined. Brazing alloys were developed for joining refractory alloys to themselves and to oxide ceramics. Procedures were established for welding a variety of loops and other components. Unique techniques were devised for field-welding refractory-metal tubes, for seal-welding corrosion capsules in vacuum, and for penetrating thin-walled thermocouple wells through thick-walled pipes. The evaporation rates of a complex commercial Co-base alloy decreased with time but were independent of pressure between 870 and 1150°C in the pressure range 6×10^{-10} to 6×10^{-7} torr. The effects of aging on the mechanical behavior of Ta-base alloys were determined. An ultra-high-vacuum technique for measuring gas-metal reactions revealed that 1% Zr in Nb increases the solubility of N_2 in Nb by a factor of 4. Creep-rupture properties of Nb-, Ta-, Mo-, and W-base alloys—including effects of heat treatment—were investigated. Of special interest are alternating-stress situations for the D-43 alloy. Effects of pretest annealing on creep-rupture behavior of Nb-base alloys were determined. A total of 38,500 hr was accumulated in refluxing capsule tests involving refractory alloys with boiling K, with very little evidence of dissolutive attack. Results of thermal-convection-loop and forced-convection-loop tests substantiated results from capsule tests. Mass-transfer effects were observed in refractory-alloy–Li systems studied in the approximate temperature range 1000 to 1300°C, and some interesting conclusions from this work are reported. Nondestructive evaluation techniques were developed and applied for Nb-, Ta-, and W-base alloys in the form of tubing. Preparation of reference standards by electrical discharge machining constituted the principal developmental effort in this work. Thermophysical properties of Nb-, Ta-, and W-base alloys were evaluated in tests developed for thermal conductivity, electrical resistivity, thermoelectric effects, specific heat, and total hemispherical emittance. (auth)

13098 (ORNL-3970, pp 85-90) TUNGSTEN METALLURGY. Harms, W. O. (Oak Ridge National Lab., Tenn.).

Thermochemical deposition (TCD) of W has continued to produce sheet material for complete metallurgical evaluation. The effects of basic deposition parameters on deposit morphology were studied in an effort to optimize the process. The texture of TCD W rolled at 1200°C was found to approach the {100} ⟨011⟩ ideal texture with increasing reduction up to 80%. The ductile-to-brittle transition temperature (DBTT) in W was examined as a function of annealing treatment and grain size. Annealing lowered the DBTT of TCD tungsten but raised that of stress-relieved powder-metallurgy material. Fracture in W appears to be initiated at grain boundaries and probably at impurities segregated there. Creep-rupture properties were measured on TCD and powder-metallurgy W, W–2% ThO_2, and Sylvania A. (auth)

13099 (ORNL-3970, pp 185-92) MEDIUM-POWER REACTOR EXPERIMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Tests using forced-circulation loops with boiling potassium have continued. The erosion damage of mockup turbine blades increased with decreasing vapor quality and was reduced by the addition of a hot trap. In natural-circulation boiling-K loops, chromium was transferred by high-purity K when TZM and stainless steel were both present in the condenser. The only attack found after 3000 hr of operation was an intergranular attack to 2 mils in a very limited area adjacent to boiling nucleation sites. A second all-stainless-steel loop with 3400 ppm oxygen added to the K in the boiler showed a similar but much heavier attack near the nucleation sites. Material was removed from inserts in the top of the condenser and deposited on those lower down, especially near the liquid level. The compatibility of six high-temperature brazing alloys with boiling K at 1500 to 1600°F for times up to 6500 hr was studied. The alloys were tested as joints between type 316 stainless steel tubing and are rated in order of increasing attack: Coast Metals 50 and 52, General Electric J8100 and J8300, and Nicrobraz 50 and 10. Nicrobraz 10 was not recommended for use in boiling K at these times and temperatures. Welds in type 304 stainless steel were cycled to failure by fatigue testing. Welds that had been heat treated at 1800°F had properties comparable to base metal, while the as-welded specimens had a shorter life expectancy. Cermet bearings of WC were brazed with an Ni–Si–B alloy to refractory metal pumps of a variety of sizes and configurations. Joints of WC brazed to TZM were successfully carburized in methane. The high carburizing temperatures required higher-melting brazing alloys; these alloys were found in the Ni–Cr–Si system. Coatings have been found that will increase the thermal emittance of both Al and stainless steel. One on Al appears stable to 600°F and one on stainless steel to 1500°F. (auth)

13100 (ORNL-3970, pp 193-203) MOLTEN-SALT REACTOR PROGRAM. Adamson, G. M. Jr.; Taboada, A. (Oak Ridge National Lab., Tenn.).

Surveillance specimens of Hastelloy N and grade CGB graphite have been assembled, placed in both the MSRE and the control test system, and exposed to molten fluorides for more than 1350 hr. The first sampling of these is scheduled for the early part of August 1966. A reduction in ductility reduces the stress-rupture life of Hastelloy N. This reduction is sensitive to neutron dose, and a stress level exists below which no embrittlement is observed. Welds in commercial Hastelloy N had poorer stress-rupture properties than did the base metal. Properties could be improved by postweld heat treatments. The welds were, however, degraded less than the base metal when exposed to neutrons. Dynamic corrosion studies with fused salts and liquid Pb have continued. Salt loops are still circulating successfully after several years of operation. Difficulties are still being encountered with plugging of the Pb loops. A loop of Nb–1% Zr operated with Pb at 1400°F for 4300 hr; how-

ever, Nb crystals were found in the cold leg. A new brazing alloy, Pd–35% Ni–5% Cr, has been developed and has successfully brazed graphite to Mo. The joints have withstood thermal cycling and exposures of 1000 hr to molten fluoride salts at 700°C. A special joint brazed with a Au–Ni alloy successfully contained molten fluoride salts at 700°C and 150 psig for 500 hr. Six new grades of graphite are being evaluated to determine their potential for use in molten-salt breeder reactors. Four are isotropic and two are anisotropic needle-coke graphite. Initial data indicate that they would have to be modified to be useful in the MSBR. (auth)

Corrosion and Erosion

Refer also to abstracts 13151, 13235, and 14120.

13101 (AGARD–509) STATE-OF-THE-ART SURVEY OF METHODS BEING USED FOR THE EVALUATION OF COATINGS FOR SUPER ALLOYS AND REFRACTORY METALS. James, W. A. (Advisory Group for Aerospace Research and Development, Paris (France)). May 1965. 26p.

Methods that were noted during a survey in 1964 on methods used for the evaluation of coatings for super alloys and refractory metals are described, and some typical results obtained by using the methods are given. The survey indicated that methods for determining physical and mechanical properties were relatively well defined, after provision was made for testing at high temperatures. By contrast, widely different methods were being used to determine resistance to corrosion, erosion, thermal shock, and thermal fatigue. Usually one or more of oxidation resistance, resistance to erosion by hot gases, and the effects of stress were evaluated simultaneously with resistance to thermal fatigue. The differences in evaluation procedures appeared to reflect differences in opinion concerning what was wanted from a test. (P.C.H.)

13102 (BMI-X-417) INTERGRANULAR MODIFICATIONS IN NICKEL FROM THE FLUIDIZED-BED FLUORIDE VOLATILITY PROCESS. Miller, Paul D.; Berry, Warren E.; Stiegelmeyer, William N.; Boyd, Walter K. (Battelle Memorial Inst., Columbus, Ohio). Nov. 28, 1966. Contract W-7405-eng-92. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Intergranular penetration could be produced in Ni-200 or Ni-201 specimens by exposure to static beds of the Al_2O_3 used for the fluidized-bed material in the processing. Two of the four grades of Al_2O_3 under consideration produced severe penetration when in contact with Ni at 520°C. S in the Al_2O_3 is thought to cause the intergranular modifications. With the exception of one grade of Al_2O_3, chemical analyses confirmed this conclusion. A spot test sensitive to S compounds showed a positive reaction to the grain boundaries of Ni coupons with modification present. Results of electron-beam microprobe analyses showed S, Fe, and O_2 at the surface of Ni specimens with intergranular modifications, but S could not be detected to a significant depth at the grain boundaries. Bend tests indicated some damage to the material from the standpoint of strength. Tensile measurements made at room temperature and at 520°C showed that the ultimate tensile strength and elongation of the Ni specimen were lowered appreciably by the intergranular modifications. The present practical means of alleviating the intergranular damage lies in bed-material selection. (auth)

13103 (EURAEC–1555) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 12, July 1–September 30, 1965. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 054-64-4 TEE B. 18p. (EUR–2696; R–2364). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

During a study on the oxidation of titanium and the recrystallization behavior of oxide films, cavities were often observed presenting specific contrast characteristics. An investigation was made of the contrast in transmission electron microscopy at such cavities or gas-filled voids, which are in equilibrium in a solid matrix. The dynamic theory of electron diffraction is used in the two-beam approximation and normal as well as anomalous absorption is taken into account. It is shown that the presence of a cavity can be adequately represented by a phase angle $\alpha = 2\pi s z_2$, which depends on the thickness z_2 of the void and on the diffraction conditions (through the excitation error s). The main result is that, contrary to other treatments, the image depends on the vertical position of the void. The theory accounts for the large variety of images, which are observed under different diffraction conditions, for different void sizes and depths. Observations of cavities in rutile (TiO_2) are discussed and good agreement with theoretical predictions is found. An analytical discussion is given for the thick-foil case, whereas computed profiles are used to deduce and to illustrate contrast features in the more general case. (auth)

13104 (EURAEC–1665) CORROSION OF STAINLESS STEELS IN HIGH TEMPERATURE WATER AND STEAM. Warzee, M.; Ruston, W. R.; de Dorlodot, P.; Hennaut, J.; Berge, J.-Ph. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Feb. 9, 1966. Contract 089-62-7-RDB. 14p. (EUR–2857.e; CONF-660514–3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

From 3rd International Conference on Metallic Corrosion, Moscow.

The corrosion of stainless steels in steam increased regularly between 200 and 300°C. This was not so in water: there, corrosion as function of temperature showed a marked maximum around 250°C for AISI 410 steel. For AISI 304 steel the maximum, which was not actually observed, must lie at a lower temperature. The quantity of dissolved metal was responsible for the maximum. It was found that magnetite crystals grow out of the solution and that this redeposition may cause underestimation of corrosion values obtained in static autoclave tests. The observed phenomenon is of great technical significance because the crystallization of magnetite from solution may cause mass transfer from cooler to hotter parts in nuclear reactors cooled with water and operating around 300°C. (auth)

13105 (EURAEC–1764) INFLUENCE OF SURFACE TREATMENT ON CORROSION OF CARBON AND STAINLESS STEELS IN HIGH TEMPERATURE WATER AND STEAM. PART II, CORROSION EVALUATION THROUGH DETERMINATION OF THE HYDROGEN FORMED IN THE REACTION. Special Report No. 6. Sonnen, C.; Warzee, M. (Societe d'Etudes, de Recherches et d'-Applications pour l'Industrie, Brussels (Belgium)). Dec. 6, 1966. Contract 089-62-7RD-B. 35p. (EUR–3319). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A method is described that permits study of the reaction kinetics of metals and alloys of the iron family in high temperature water and steam, under mechanical stress. Potential applications and limitations of the method are defined from results obtained with boilerplate steel and an austenitic stainless steel (AISI 304 L) oxidized in water and steam at temperatures ranging between 300 and 450°C. Curves giving the evolution of total corrosion and of the corrosion rate confirmed the influence of the surface state previously established by tests in autoclaves. The effects of this influence appear in the first few moments of the reaction and generally remain over long tests. (auth)

13106 (JAERI–1116) CORROSION OF ZIRCALOY-2 AND 4 IN HIGH TEMPERATURE AND HIGH PRESSURE BOILING WATER AND STEAM. Nomura, Sueo; Ito, Noboru (Japan Atomic Energy Research Inst., Tokyo). Aug. 1966. 11p. (In Japanese). Dep. mn.

Two kinds of Zircaloy-2 and one kind of Zircaloy-4 were corroded in 280°C boiling water and 400°C steam at pressure 64 kg/cm^2 G. Remarkable corrosion was observed where a stringer was located, and the corrosion was larger in the flowing condition of water or steam than in the stagnant. Further, it was increased with increasing oxygen content of the water or steam. By the weight gain-time curves for the three kinds of specimens, it was indicated that the difference in weight gain was caused by the difference in the reaction rate constants of the different specimens, although the time dependency of weight gain was constant. The difference in the reaction rate constant was considered as due to the morphological difference of the corroded specimen surfaces, by the impedance measurement and optical- and electron-microscopic observation of the surface oxide films of the specimens. (auth)

13107 (N–66–38146) POTASSIUM CORROSION TEST LOOP DEVELOPMENT. Quarterly Progress Report No. 10, October 15, 1965–January 15, 1966. Hoffman, E. E. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). June 9, 1966. Contract NAS3-2547. 41p. (NASA-CR-54990). CFSTI $3.00 cy, $0.65 mn.

The development and endurance testing (5000 hours) of a prototype corrosion test loop for the evaluation of refractory alloys in boiling and condensing K environments which simulate projected space electric power systems are reported. The prototype test consists of a two-loop Nb–1Zr facility; Na is heated by direct resistance in the primary loop and used in a heat exchanger to boil K in the secondary corrosion test loop. It is reported that a total of 3,809 hours of the 5,000 hour test was completed when a pressure rise in the test chamber necessitated a shutdown. The

pressure rise resulted from stress-corrosion cracking of one of the stainless steel water cooling channels of the test chamber wall, and emphasis is placed on methods and procedures used in repairing this failure. (STAR)

13108 (ORNL–3970, pp 50–3) SURFACE REACTIONS OF METALS. Cathcart, J. V. (Oak Ridge National Lab., Tenn.).

X-ray and electron-microscopic techniques were used to compare surface topography, mosaic spread, average strain, and other structural details of the oxide on several dilute Cu-base alloys (notably Cu–Ni) with the corresponding parameters for the oxide on pure copper. Oxidation-rate changes were correlated with changes in the extent of the paths of easy diffusion in the oxide. The studies of the aqueous corrosion of Al alloys in high-temperature water were extended to include binary Al alloys containing Zr, Mg, Cu, Fe, and Be. All reduced the corrosion rate of Al. Pronounced corrosion-rate minima were observed in the Al–Y and Al–Zn systems, the increase in rate at the higher concentrations being related to renewed intergranular attack. The technique of thermally oxidizing a previously anodized specimen proved useful in studying oxygen-solution effects in Ta and Nb. Additional measurements of the flexure of oxidizing Nb and Ta were rationalized in terms of stresses associated with oxygen solution in the metal followed by a stage in the oxidation process in which stresses within the oxide layer itself control flexure. Finally, a suitable technique was developed for removing anodic films from Nb–Ta alloys and for preparing other refractory-alloy oxide films. These specimens should be useful for studies of oxide-phase stability and of the influence of alloying elements on the oxidation of refractory metals. (auth)

13109 (ORNL–3970, pp 81–4) MATERIALS COMPATIBILITY. DeVan, J. H. (Oak Ridge National Lab., Tenn.).

Corrosion in the Nb–O–K system at 1000 and 1250°C is controlled by solid-state diffusion of O_2 from the NbO. The driving force seems to be the tendency to form mixed metal oxides, in agreement with previous results at lower temperatures. At 815°C Nb–1% Zr specimens containing an oxygen-to-Zr atom ratio less than 2 took up oxygen, while specimens with a ratio greater than 2 lost oxygen. Thus the direction of oxygen movement appears to depend on whether the atom ratio of oxygen is less than or greater than that corresponding to ZrO_2. A unique fast-neutron activation analysis facility suitable for handling highly active alkali metals without protective capsulation was designed and is under construction. A molecular distillation rig is being developed which is capable of refining alkali metals to higher purity than has been possible with other methods. (auth)

13110 (ORNL–3970, pp 245) SNAP-8 AND SNAP-50 CORROSION STUDIES. Litman, A. P.; Taboada, A. (Oak Ridge National Lab., Tenn.).

Corrosion support programs for the SNAP-8 and SNAP-50 reactor systems were continued. Studies on the former were completed, and a summary report was issued. The most pronounced performance-deteriorating corrosion phenomenon found was C migration from the Croloy 9M to the other structural materials in the system (chromized Hastelloy N, types 347 and 316 stainless steel, and Hastelloy C) in contact with the eutectic NaK. The bimetallic heat-rejection loop, made from type 316 stainless steel and Nb–1% Zr alloy, studied in support of SNAP-50, completed its scheduled 6000-hr operation with eutectic NaK, was dismantled, and is being examined. Removable and permanent specimens of both structural metals located in the heated section showed very small or no weight change. (auth)

13111 (USNRDL-TR-1092) MEASUREMENT OF SEAWATER CORROSION OF SNAP CONTAINER ALLOYS USING RADIOACTIVE TRACER TECHNIQUES. Kubose, D. A.; Lai, M. G.; Goya, H. A.; Cordova, H. I. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 10, 1966. Contract AT(49-5)-2084. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Corrosion rates of Haynes 25, Hastelloy C, and Hastelloy N in seawater were measured using two radioactive tracer techniques. These techniques involved measurement of the radioactivity leached into seawater from radioactive alloy specimens and performing neutron activation analysis of corrosion products in seawater in which inactive alloy specimens were placed. The second technique was used to determine whether the gamma recoil from the thermal neutron activation of the alloys in the first technique affected their corrosion properties. It was found that the gamma recoil from neutron activation had only a small effect on the corrosion rate of the alloys. The average corrosion rates obtained for Hastelloy C and Hastelloy N were 0.5×10^{-4} mil per year and 1×10^{-4} mil per year, respectively. No appreciable differential leaching of the Co, Ni, and Cr components of these alloys was observed. The results obtained for Haynes 25 indicated differential leaching had occurred. The corrosion rate calculated from the amount of Co released was 1×10^{-6} mil per year while that calculated from the amount of Cr released was 4×10^{-4} mil per year. Results of experiments in which specimens of Haynes 25 in seawater were exposed to bremsstrahlung and ^{60}Co radiation indicated no significant effect of ionizing radiation on the corrosion rate for exposures up to 10^8 rads. (auth)

13112 (WCAP–3269–57) THE POST-IRRADIATION EXAMINATION OF SAXTON FUEL CLADDING CORROSION PRODUCTS. Picone, L. F.; Fletcher, W. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1966. Contract AT(30-1)-3269. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Corrosion product deposition on fuel clad surfaces can affect the reactor thermal and hydraulics characteristics, the core reactivity, and also be a significant contribution to plant activation. Fuel assemblies from the Saxton Core I were examined after exposure at various times to coolant chemistries and nuclear conditions. It was established that no significant difference exists between deposition on stainless steel and Zircaloy fuel cladding and further that the actual amount of deposition is small under normal PWR operating conditions. The results of the visual examinations of these assemblies together with some chemical and radiochemical data obtained from deposit samples are discussed in relation to the factors that affect corrosion product deposition. (auth)

13113 HOW URANIUM AFFECTS CORROSION OF RESULFURIZED STAINLESSES. Biefer, Gregory J.; Crawford, William M. (Department of Mines and Technical Surveys, Ottawa). Metal Progr., 90: No. 6, 119–20(Dec. 1966).

Because ferritic stainless steels such as AISI type 430 resist corrosion by nitric acid, they are used widely for chemical processing components. Resulfurization, however, significantly impairs this resistance though it aids machinability. It was found that this effect can be reversed by addition of up to 1.5% uranium to 416 and 430F. With addition of sufficient uranium, sulfides became predominantly globular and retain their shape through hot rolling. (W.D.M.)

13114 CHEMISORPTION AND OXIDATION: OXYGEN ON TUNGSTEN. McCarroll, Bruce (General Electric Research and Development Center, Schenectady, N. Y.). J. Chem. Phys., 46: 863–9(Feb. 1, 1967).

Oxygen chemisorption and the extent of oxidation on a W ribbon at room temperature were studied by flash desorption using line-of-sight detection with a time-of-flight mass spectrometer. The only chemical species in the adlayer are O atoms and the oxides WO, WO_2, and WO_3. These oxides are desorbed with an energy of ~100 kcal. In agreement with earlier predictions, O desorbs as atoms. Neither O_2 nor polytungstic oxides were ever observed from a ribbon flashed after a room-temperature exposure to O_2. However, flowing O_2 on W at surface temperatures >1400°K does produce the polytungstic oxides. An order-of-magnitude estimate of the adlayer composition at room temperature suggests that at saturation there is approximately one monolayer of O atoms in a random configuration with a few tenths of a per cent each of the monotungstic oxides. Consequently, oxidation is not a significant surface process on clean W at room temperature. (auth)

13115 KINETICS OF THE OXYGEN–TUNGSTEN REACTION AT HIGH TEMPERATURES. Walsh, Patrick N.; Quets, Jean M.; Graff, Robert A. (Union Carbide Research Inst., Tarrytown, N. Y.). Contracts DA-01-021-AMC-11926(Z); DA-30-069-ORD-2787. J. Chem. Phys., 46: 1144–53(Feb. 1, 1967).

The rate of reaction of O_2 with W was measured from 2000 to 3300°K at pressures from 0.11 to 11.5 torr. High gas-phase mass transfer coefficients were obtained by impinging a high-velocity gas jet on the sample. A maximum reaction rate was observed at each O_2 pressure, the temperature of maximum rate increasing with pressure. Below the temperatures of the maxima, an apparent activation energy near 23 kcal $mole^{-1}$ was observed. These results are well described by the empirical equations of Perkins, Price, and Crooks, except that no transition to a regime of higher activation energy at lower temperatures was observed here and the maxima were found at slightly higher rates and temperatures than previously reported. Appreciable diffusion effects were found only near the observed maxima. These data and the 10^{-4} torr data of Schissel and Trulson were correlated in terms of the two-layer oxygen-atom adsorption model for W oxidation kinetics proposed by the latter authors. Kinetic constants for a slightly modified version of this model were obtained. (auth)

13116 STRESS CORROSION OF BERYLLIUM IN SYNTHETIC SEA WATER. Miller, R. A. (Aerospace Research Lab., Wright-Patterson AFB, Ohio); Myers, J. R.; Saxer, R. K. Corrosion, 23: 11–14(Jan. 1967).

Continuous total-immersion testing of pickled Be sheet material in synthetic sea water revealed that the corrosion rate decreases

asymptotically from about 21.5 to 2.0 mpy as the exposure period increased from 5 to 150 days. Be was observed to be susceptible to severe pitting attack. Testing established that Be is susceptible to stress-corrosion when exposed to synthetic sea water. Time-to-failure decreased from about 2340 to 40 hours as applied tensile stress was increased from 1220 to 40,000 psi. Electron fractography studies suggested that stress-corrosion failure occurred transgranularly. (auth)

13117 OXIDATION OF TANTALUM COATED WITH ALUMINUM AND ALUMINUM–CHROMIUM ALLOYS. Kofstad, P.; Espevik, S. (Central Inst. for Industrial Research, Oslo). J. Less-Common Metals, 12: 117-38(Feb. 1967).

The oxidation of Ta and Ta–10% W hot-dipped in Al and Ta hot-dipped in Al–Cr alloys was studied in the temperature range from 800 to 1600°C and at O_2 pressures ranging from 0.1 torr to 1 atm. The experimental studies comprised thermogravimetric measurements of oxidation, and x-ray diffraction studies, metallographic investigations, and electron-microprobe analyses on reacted specimens. Unalloyed coatings on Ta and Ta–10% W gave at 0.1 torr O_2 excellent oxidation resistance at temperatures above 1100°C, but at 800 to 1000°C breakaway oxidation occurred. The protectivity was provided by an α-Al_2O_3 layer. At 1 atm O_2 the unalloyed coatings failed at all temperatures. The interdiffusion of Al and Ta led to the formation of $TaAl_3$, Ta_3Al, the Ta–Al σ-phase with approximately 7 to 9 wt % Al, and a Ta–Al phase with approximately 20 wt % Al. The Al–Cr coatings exhibited significantly improved performance compared with the pure aluminide coatings. At 0.1 torr O_2, Al–20% Cr and Al–30 % Cr coatings on Ta provided excellent oxidation protection above 1000°C and at 800 to 1000°C breakaway oxidation was significantly retarded. Increasing concentrations of Cr also reduced failures at 1 atm O_2, and good protection could be achieved with Al–30% Cr coatings in 1 atm O_2 at 1500°C. The protectivity is provided by a layer of the α-Al_2O_3 phase (Al_2O_3–Cr_2O_3 solid solution). (auth)

Preparation and Fabrication

Refer also to abstracts 12296, 12388, 13141, 13160, 14058, and 14087.

13118 (ANL–7151) DEVELOPMENT OF TECHNIQUES FOR FABRICATION OF SMALL-DIAMETER, THIN-WALL TUNGSTEN AND TUNGSTEN-ALLOY TUBING. Interim Progress Report, January 1, 1964–December 31, 1965. Burt, W. R. Jr.; Brillhart, D. C.; Mayfield, R. M. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress in the fabrication of small-diameter, thin-wall W and W alloy tubing is summarized. Methods are described for producing W or W–25 wt % Re tube-blanks by double extrusion. The starting material, generally a pressed and sintered product, is in the form of a sleeve 3.17-cm OD × 2.54-cm ID × ~10.2 cm long (1.25-in. OD × 1.00-in. ID × ~4.0 in. long). Both initial and re-extrusion processes use the filled-billet technique. The resultant tube-blanks, ~0.64-cm OD × 0.51-cm ID × 75 cm long (0.25-in. OD × 0.20-in. ID × 30 in. long), are structurally sound and suitable for secondary fabrication operations. Secondary fabrication operations were concentrated on the W-25Re alloy. Plug drawing emerged as an excellent technique, both for the reduction of the overall tube dimensions and for the removal of the longitudinal surface striations resulting from the filled-billet extrusion sequence. Plug drawing also obviates the need for core removal at the finished-tube size (<0.125-in. OD). Even at larger tube sizes, core removal remains a problem, and improved methods are being sought. Crack-free swage pointing of the small-diameter W-25Re tubing is difficult unless proper dies and swaging techniques are employed. Progress in this area is presented. (auth)

13119 (APED–4923) LOW-CYCLE FATIGUE TESTING OF PARTIAL PENETRATION WELDED REACTOR VESSEL NOZZLE CONNECTIONS. PART II. FABRICATION ASPCTS. Hackney, B. D.; McDaniel, C. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1966. 25p.

Low-cycle fatigue testing of partial penetration welded reactor vessel nozzle connections is considered with emphasis on the fabrication aspects of the program. Fabrication of "straight-through" and "socket" nozzle connections is discussed insofar as sequence and areas of difficulty in fabrication are concerned. Test specimens representing actual geometries and typical sizes of control rod drive nozzles were fabricated of commercial engineering materials. Material representing the vessel bottom head was ASTM A508, Class 2, while the control rod drive housing and tube nozzle materials included Type-304 stainless steel, Inconel 600, and carbon steel. (M.C.G.)

13120 (CEND–3742-293) VANADIUM PURIFICATION. Quarterly Progress Report No. 2, October 1, 1966–January 31, 1967. Shen, Y. S.; Worcester, S.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Jan. 1967. Contract AT(30-1)-3742. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The program was successful in attaining V with a total interstitial content of 790 ppM. Neither gettering agents nor melting practice were able to reduce nitrogen levels. Therefore, a decision was made to procure low-nitrogen feed stock. An order was placed with the Columbium Reduction Department of the Wah Chang Corporation to produce low-nitrogen V from V_2O_5 by aluminothermic reduction. Reduction of approximately 250 pounds of V should be accomplished during the month of January. During the last quarter, equipment for electron-beam melting the three-inch ingots was designed and manufactured. (auth)

13121 (COO–1518-4) FABRICATION OF TUNGSTEN ALLOY TUBING. Report for Period, July 1, 1965–June 14, 1966. Sowman, H. G.; Milner, A.; Rowenhorst, D. D. (Minnesota Mining and Mfg. Co., St. Paul). Dec. 23, 1966. Contract AT(11-1)-1518. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A 3M-developed powder metallurgical fabrication process was adapted to the manufacture of small diameter tubing in W–26 at. % Re and W–30 at. % Mo–30 at. % Re alloys having useful engineering properties. Results show that good quality tubing was produced which was ductile at room temperature in the as-sintered condition, and capable of being successfully processed by both plug and mandrel drawing. (auth)

13122 (IITRI–B6072-1) VANADIUM ALLOY STUDIES. Quarterly Report No. 1, November 10, 1966–January 10, 1967. (IIT Research Inst., Chicago, Ill.). Feb. 10, 1967. Contract N00019-67-C-0122. 11p.

The development of V-base alloys centered on V–20 Nb–10 Ti and V–Nb–Ta base compositions complexed with small additions of Si and C. Aging studies on sheet specimens solutionized at 2200°F show rapid and substantial hardness increases on specimens aged at 1300°F; much slower aging response was obtained at 1200°F. Initial data on specimens solutionized at 2000°F indicate a moderate increase in room temperature strength after aging at 1300°F. (auth)

13123 (IS-RD–8) REACTOR MATERIALS DEVELOPMENT QUARTERLY FOR DIVISION OF REACTOR DEVELOPMENT, OCTOBER–DECEMBER 1966. Voigt, A. F. (ed.) (Ames Lab., Iowa). Contract W-7405-eng-82. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: preparation and purification of Th, Yt, and V; phase diagrams of rare earth systems, refractory metal systems, and C–Th system; reactor materials development; and properties of materials at high temperature. (P.C.H.)

13124 (N–66-33538) THE FABRICATION OF BERYLLIUM. VOLUME I. A SURVEY OF CURRENT TECHNOLOGY. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). July 1966. 149p. (NASA-TM–X-53453). CFSTI $3.00 cy, $0.65 mn.

The fabrication of Be and its alloys into space-vehicle structures is discussed. Currently used methods for fabricating the metal into sheets, rods, and other forms are summarized. Some of the difficulties encountered in various aspects of fabrication, especially regarding the inherent brittleness of the metal, are enumerated along with the means that were used to circumvent these problems. The survey includes 102 references to articles and papers in the unclassified literature, most of them published since 1960. (STAR)

13125 (NP–16510) DEVELOPMENT OF HIGH-STRENGTH MOLYBDENUM- AND TUNGSTEN-BASE ALLOYS. Final Report, March 1, 1965–May 1, 1966. Semchyshen, M.; Kalns, Eric; Klaphaak, Daniel J.; Barr, Robert Q. (Climax Molybdenum Co. of Michigan, Ann Arbor). Dec. 30, 1966. 102p.

Solid-solution-strengthened W base alloys were vacuum-arc-cast with relatively large additions of Ta, Nb, and/or Mo. Machined blanks from the ingots were extruded to round bar stock at temperatures from 3600 to 4000°F. Extrusion recoveries varied considerably from heat-to-heat. Elevated-temperature tensile tests were performed on specimens machined from available extruded bar stock. Strengths were well above those reported for unalloyed W, but were below those resulting from earlier studies on dispersion-strengthened W-base alloys. Mo-base alloy sheets were prepared representing two compositions and three thermomechanical histories. Compositions studied were Mo + 1.25% Ti + 0.3% Zr + 0.1% C (TZC), and Mo + 0.3% Zr + 0.03% C. The thermomechanical variables imposed were solution heat treatments

at various stages during the working schedules. Recrystallization behavior, bend transition temperatures, and tensile properties were quite sensitive to working schedules. Contrary to previous results, it was found that a much more favorable trade-off between strength and transition temperature can result from the proper placement of the solution treatment in the working schedule. Some preliminary work was performed to explore the possibility of forming nitrides during arc casting of Mo containing a strong nitride-forming element. An addition of Hf was made in the present case. The results suggested that the technique represents a potential method of providing stable dispersoids in Mo. (auth)

13126 (ORNL-3970, pp 125-35) SINTERED ALUMINUM PRODUCTS DEVELOPMENT. Douglas, D. A. Jr. (Oak Ridge National Lab., Tenn.).

A study is being conducted to determine the material and processing parameters necessary to produce a desired end product consistently and economically, and to improve our understanding of the mechanical behavior of SAP so that maximum benefit may be derived from proper control of the material and processing parameters. Characterization of various forms of Al powder has revealed that use of metal flakes within a controlled size range produces a stronger and more homogeneous final product. The oxide morphology can be controlled and agglomeration prevented by exposing the powders to vacuum at 600°C. Fractograph studies have revealed that SAP fail in a ductile manner at low strain rates above 400°C, even though total uniform elongation is less than 0.5%. Electron microscopy studies indicate that strengthening in SAP is not related to stabilization of a cold-worked structure at high temperatures. The as-milled flake is completely recrystallized with a very low dislocation density. Hot working of SAP compacts significantly improves the rupture strength of the material. A process flowsheet has been developed, and process variables are being investigated at each important step. Quality control techniques are under investigation to monitor the product at selected stages of fabrication. (auth)

13127 (ORNL-3970, pp 225-30) ISOTOPIC HEAT SOURCE DEVELOPMENT. Beaver, R. J. (Oak Ridge National Lab., Tenn.).

A program was inaugurated to investigate materials of current and future interest for encapsulating isotopes to be used as heat sources. The main effort has been associated with development of remote electron-beam welding techniques for refractory alloys and studies of the creep resistance of the Ta-base alloys T-111 and T-222, particularly applied as pressure-vessel materials for alpha-emitting isotopes. The compatibility of Pt as a braze metal between Ir and W-base alloys for high-temperature application was examined. Thermal conductivity of solid and liquid Pm and of a bed of PuO_2 spheroids in inert atmospheres was calculated. (auth)

13128 (ORNL-3970, pp 246-7) THERMONUCLEAR PROJECT. Leonard, W. J. (Oak Ridge National Lab., Tenn.).

Failures in Cu tubing to extreme conditions were analyzed, lead alloys with increased Li content were developed, and W probes with BN insulation were fabricated. The last of these required unique extension of thermochemical deposition processes. (auth)

13129 (SC-TM-346-63(14)) MULTIPLE SOURCE AND MASK WORK TABLE FOR VACUUM EVAPORATION. Komarek, E. E. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 22p. DTIE.

A multiple-source microcircuit jig was designed, which combines a mask and source changing apparatus with electron bombardment for vacuum evaporation. Six sources and six masks may be selected independently for multiple-layer depositions in one pump-down cycle. Materials were evaporated, which have melting points ranging from 620°C for Al through 1420°C for Si to 2600°C for Mo. (auth)

13130 FORMATION OF ROLLING TEXTURE OF BODY-CENTERED CUBIC METALS AND ALLOYS. I. THE INFLUENCE OF DEFORMATION CONDITIONS ON THE ORIGIN OF ROLLING TEXTURE. Haessner, Frank; Mayer-Rosa, Dieter (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 12-19(Jan. 1967). (In German).

The formation of the rolling texture throughout the cross section of the sheet at different external deformation conditions was investigated on Nb, Ta, V, Fe, Ta–O system, and a Nb–34 wt % alloy. With equal initial and rolling conditions, the same type of texture was found inside the sheet with all materials investigated. Between −196 and 500°C this type did not depend on the temperature for Nb. The texture was merely more pronounced with decreasing rolling temperature. The microstructure in the rolling plane consisted of a random dislocation arrangement. On vanadium addition formation of the (001) [100] component was preferred orientations. Through the cross section of the sheets pronounced texture inhomogeneities arose. Investigations of Nb and Ta in this respect indicated that three layers may be distinguished: a surface layer of approximately 1 to 3 μm thickness whose crystallite orientation depends strongly on the rolling conditions; a subsequent thin layer with a texture that is very pronounced at a reduction of area as small as 75%; and a thick layer within the material, which exhibits an almost random crystallite distribution. At higher degrees of rolling this layer developed more or less uniformly, the normal rolling texture. The surface layer was, also, observed in Fe and V. (auth)

13131 STEADY STATES DURING ANNEALING OF NIOBIUM AND TANTALUM IN OXYGEN. Fromm, Eckehard; Jehn, Hermann (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 61-6(Jan. 1967). (In German).

On annealing Nb and Ta in an O_2 atmosphere in certain temperature and pressure ranges steady states were established between the absorption of O_2 and the evaporation volatile oxides. The steady states were investigated quantitatively at temperatures between 1870 and 2500°C and at pressures from 5×10^{-4} to 2×10^{-3} torr. Relations were established between the O_2 pressure, annealing temperature, and O_2 concentration of the specimen. Also, the rates of O_2 absorption were determined in the investigated temperature range. (auth)

13132 BRAZING MOLYBDENUM AND ZIRCON SENSOR COMPONENTS. Curran, Robert E.; Mendelsohn, Lewis I. (General Electric Co., West Lynn, Mass.). Contract NOw 63-0283F. Metal. Progr., 90: No. 6, 94-5(Dec. 1966).

Molybdenum and zircon components of a pressure sensor for operation under vibration between −65 and 1000°F and at 0 to 3750 psig were joined by metallizing and copper plating the zircon and then furnace brazing the parts in two steps in hydrogen. The main sensor element is comprised of two capacitor plate holders and a molybdenum cantilever spring. Six separate brazes were required to join the seven components. (W.D.M.)

13133 NEW DEVELOPMENT DIRECTIONS IN POWDER METALLURGY. Kieffer, R.; Jangg, G. (Technische Hochschule, Vienna). Chem.-Ing.-Tech., 39: No. 1, 43-53(Jan. 1967). (In German).

Examples illustrate a survey of the more important developments in powder metallurgy and the production and molding of the powder, during the last ten years. The properties imparted to, and the more recent applications of powder-metallurgical products, e.g., high-melting metals, hard-metals, non-scaling materials, and metallizing alloys, sintered iron or copper alloy moldings, metallic bonded articles, dispersion-hardened alloys, are presented. The importance of powder metallurgy attained in various branches of industry, in (automobile manufacture, the electrical industry, nuclear technology and space-rocket development) is discussed. (auth)

13134 THERMAL INSULATING MATERIAL. Sheriff, Norman. (to United Kingdom Atomic Energy Authority). British Patent 1,050,529. Dec. 7, 1966. Filed Oct. 18, 1962.

A thermal insulating material is described that has particular application for use on prestressed concrete pressure vessels of nuclear reactors. The material comprises a metal foil with a filament joined to one side of it. The filament serves to space the side of the foil to which it is attached away from an opposing side of another metal foil by not more than 0.040 in. (0.1 cm) while the filament provides support for the foils by line contact with their opposing sides. The filament has a diameter in the range of 0.020 in. (0.05 cm) to 0.040 in. (0.1 cm) and is a metal wire arranged in a tortuous path and tack welded to the foil at the bends in the path. (B.L.M.)

Properties Evaluations

Refer also to abstracts 12332, 13101, 13122, 13123, 13125, 13126, 13214, 13258, and 13260.

13135 (AD-639314) DEFORMATION PROCESSING OF ANISOTROPIC METALS. Final Report, July 1, 1965–June 30, 1966. Backofen, W. A.; Holt, D. L.; Lee, D.; Martin, P.; Azzarto, F. J. (Massachusetts Inst. of Tech., Cambridge. Metals Processing Lab.). July 1966. Contract NOw-66-0068. 100p. CFSTI $3.00 cy, $0.65 mn.

Studies were made on superplasticity in Al–Cu eutectic alloy, Ti and Zr alloys, electroplated composites of Pb and Sn, and pellet- and ingot-extrusions of the Mg alloy ZK60. (TAB)

13136 (ANL-7067) CLADDING FAILURE SIMULATION TESTS IN EBR-II. Smith, R. R.; Doe, C. B. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two independent systems, one based on the detection of rare

gas fission products in the cover gas (CWD), and the other based on the detection of delayed-neutron-emitting fission products in the primary coolant (FERD), were used to evaluate the nature of a failure in cladding for fuel elements for the EBR-II. The results showed that both systems are capable of annunciating changes in the rate of release of fission products when a single unclad fuel pin is deliberately installed in the core. Both systems respond unambiguously: the CWD with a S/N ratio of 12, and the FERD with a S/N ratio of 6.7. The FERD system has the advantage of a much shorter time response (approximately 20 sec), but it will very likely not respond to a failure that occurs in the gas region. Since the CWD system is sensitive to failures of both types, i.e., bond-type and gas-type, the two systems logically complement each other. (P.C.H.)

13137 (APED-4904) LOW-CYCLE FATIGUE TESTING OF PARTIAL PENETRATION WELDED REACTOR VESSEL NOZZLE CONNECTIONS. PART I. TESTING TECHNIQUES. Hackney, B. D.; McDaniel, C. J.; Tagart, S. W. Jr. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1965. 33p. (65-APE-10).

Low-cycle fatigue testing is being carried out on welded reactor vessel nozzle connections. The techniques employed in testing straight-through and socket types of nozzle connections are described. Type-304 stainless steel and Inconel-600 housing materials are being tested at three levels of total stress. The experimental program is explained, and the test equipment and operation of the test facility is described. Finally, a discussion of the accuracy to which test variables are determined is presented. (auth)

13138 (APED-4948) THERMAL FATIGUE TESTING OF SELECTED DISSIMILAR METAL WELDS. Hackney, B. D.; Herbert, P. J.; Hubbard, A. M.; McDaniel, C. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1966. 95p.

Welded dissimilar metal specimens composed of Type-304 stainless steel and Inconel-600 in combination with four grades of carbon and low-alloy steels were thermally cycled through temperature ranges of 200 to 600°F, 200 to 950° F, and 200 to 1200°F for 5000 cycles or until failure. Initial, final and incremental examinations of specimens were conducted by various methods including radiography, liquid penetrant, ultrasonic, dimensional, stress analysis, hardness, and metallography. None of the specimens tested at low (200 to 600°F) temperatures suffered significant damage. Under the severest (200 to 1200°F) test conditions the Inconel-600 to low-alloy steel, Grade P5 (5 Cr–½ Mo) specimen performed best while the Type-304 stainless steel to low-alloy steel, Grade P5 (5 Cr–½ Mo) performed least satisfactorily. (auth)

13139 (COO-1319-47) INVESTIGATION OF THE FREQUENCY OF ANNEALING TWINS IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Cowan, R. L.; Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Oct. 1966. Contract AT(11-1)-1319. 84p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A possible link between the stacking fault energy and the frequency of annealing twins in the Fe–Ni–Cr alloy system was investigated. Because of the similarity between a twin interface and a stacking fault, it was expected that the frequency of annealing twins should be inversely related to the stacking fault energy. Based on the mechanism of annealing twin formation, the best correlation should occur when the different alloys studied were given the same amount of prior cold work and were grown in the same grain size by anneals at the same temperature. As a measure of twinning frequency the mean number of twins per grain was determined by direct counting. Comparisons were then made by the use of statistical theory. As a result of these measurements, it was found that the twinning frequency did not exhibit the same sign of coefficient as the stacking fault energies determined at room temperature. (auth)

13140 (EURAEC-1761) WELDED CONNECTIONS MADE FROM THICK HIGH-STRENGTH STEEL. TESTS, USING FRACTURE CRITERIA BASED ON NEW CONCEPTS AND THE INFLUENCE OF STRAIN RATE. Quarterly Report No. 4, July 1, 1966–September 30, 1966. (Oerlikon Elektrodenfabrik Eisenberg G.m.b.H. (West Germany)). 94p. (EUR-3316). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of investigations into the influence of notch sharpness on welded connections of high-strength steel are presented. Oscillographs of force/space curves obtained in coherency tests are included. (M.C.G.)

13141 (GEMP-63) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 63. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 30, 1966. Contract AT(40-1)-2847. 144p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on high-temperature physical and mechanical properties of reactor materials, radiation effects on fast reactor cladding and structural materials, technology of refractory metal alloys, physical metallurgy of refractory metal alloys, physico-chemical properties of Fe–Cr–Al clad fuel systems, advanced long-life reactor fuel cladding and structural materials development, radiation effects on heat-resistant metals and alloys, plastic fatigue properties of heat-resistant alloys, advanced pressure vessel materials, physico-chemical properties of clad UO_2 in potential meltdown environments, high-temperature thermocouple and electrical materials, and high-temperature carbides for fuel and structural applications. (P.C.H.)

13142 (INR-738/XVIII/PP) PROTOTYP PLAZMOTRONU INDUKCYJNEGO WIELKIEJ CZESTOTLIWOSCI. (Prototype of the Induction-Coupled Plasma Torch). Lewandowski, B. (Institute of Nuclear Research, Warsaw (Poland)). Aug. 1966. 34p. (In Polish). Dep.

A description is given of the design of an induction-coupled plasma torch. The operating parameters and thermal characteristics of the torch with a water-cooled chamber are given. A description of the hf unit is also given. The plasma torch was applied to investigating the powder-spheroidization processes of materials used in reactor fuel technology. (auth)

13143 (MLM-1328) REACTOR FUELS AND MATERIALS DEVELOPMENT PLUTONIUM RESEARCH: 1965 ANNUAL REPORT. Wittenberg, L. J.; Grove, G. R. (Mound Lab., Miamisburg, Ohio). Jan. 20, 1967. Contract AT-33-1-GEN-53. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on phase studies on Pu–Ce–Ni, Pu–Ce–Fe, Pu–Au, and Pu–rare earth alloys; crystal structure of $PuCu_6$; allotropic transformations of Pu; thermal analysis techniques; calorimetry of δ, δ′, and ϵ Pu; densities of liquid Nd and Pu–Ce alloys; viscosities and liquidus temperatures of Pu–Ce alloys; viscosities of liquid Pb, Sn, U, and Yb; and UO_2 microspheres. (P.C.H.)

13144 (N-66-26752) THE EFFECT OF MODERATELY ELEVATED TEMPERATURE ON THE FATIGUE LIVES OF NOTCHED (K_T = 4) SPECIMENS WHICH CONTAIN RESIDUAL STRESS. Imig. Leland A. (Virginia Polytechnic Inst., Blacksburg). Apr. 1966. 65p. (NASA-TM-X-57565). CFSTI $3.00 cy, $0.65 mn.

Thesis.

Fatigue tests were conducted on notched (K_T = 4) fatigue specimens of duplex annealed Ti–8Al–1Mo–1V sheet material (0.050 gage). Additional specimens were subjected to a single cycle of high nominal stress (called stress conditioning) prior to being tested in fatigue. Changes in fatigue lives as compared to the initial tests were noted. Further tests were made in which specimens were exposed to temperature variation between the stress conditioning and fatigue tests. The three temperatures were laboratory ambient (approximately 70°F), 300 and 550°F. The changes in fatigue life with exposure duration were noted for each temperature. (STAR)

13145 (N-66-33504) DEVELOPMENT OF HIGH TEMPERATURE NICKEL-BASE ALLOYS FOR JET ENGINE TURBINE BUCKET APPLICATIONS. Interim Engineering Report No. 2, October 1, 1965–May 31, 1966. Collins, H. E. (TRW Inc., Cleveland, Ohio. Materials and Processes Dept.). June 20, 1966. Contract NAS3-7267. 145p. (NASA-CR-72011; TRW-ER-6873). CFSTI $3.00 cy, $0.65 mn.

A screening study was conducted in which 75 experimental compositions were melted, cast, and evaluated on the basis of mechanical property, microstructure and workability results. From this study, three promising cast and five promising wrought alloys were established and recommended for a more complete property evaluation. The elements most influential in improving stress rupture life were Ta, W, Hf, Al, and Cr. It is stated that these elements, in the percentages suggested, generally increase life and tensile strength, but they normally decrease ductility and workability. The data obtained from these investigations are given, and the alloy candidates recommended for further evaluation are identified. (STAR)

13146 (N-66-34376) DESORPTION KINETICS OF MULTIPLE ADSORBATES: CESIUM WITH FLUORINE ON MOLYBDENUM AND TUNGSTEN. Tower, Leonard K. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1966. 37p. (NASA-TN-D-3596). CFSTI $3.00 cy, $0.65 mn.

Thermionic diodes containing multiple additives have received attention because of the increased durability of the surface layers and their low work functions. Factors responsible for the en-

hanced durability of the multiple coating were examined. Activation energies for desorption of Cs from fluorinated Mo and fluorinated W were deduced from experimental data. The fluorine serves to increase the activation energy for desorption of Cs from the surface. The energies for desorption of Cs from fluorinated Mo and fluorinated W at low Cs coverages were found to be similar to the dissociation energy of the CsF molecule. Activation energies for the desorption of fluorine from W and from Mo were also computed from published experimental data. A simple means of predicting these quantities for halogens on a variety of substrates is discussed, and values are presented. Hf and Ta may bind the halogen layers more tightly than other refractory metals, with Os binding more weakly. These contrasting properties may prove of value in construction of power-producing thermionic devices. (auth)

13147 (N-66-35022) MODIFIED EUTECTIC ALLOYS FOR HIGH TEMPERATURE SERVICE. Second Year Interim Report, May 1965-June 1966. Ramseyer, S. F.; Wallace, J. F. (Case Inst. of Tech., Cleveland, Ohio). 1966. 78p. (NASA-CR-77385). CFSTI $3.00 cy, $0.65 mn.

The methods for control of cast structure, i.e., eutectic modification, grain refinement, and directional solidification, are described in detail. The techniques and theories of eutectic modification and structure refinement were then used to improve the properties of superalloys over those currently obtained with cast Ni-W and Co-W alloys; criteria were established to develop the desired as-cast structures; and variations in the as-cast structure were correlated with high temperature properties. It was shown, from the survey of both the Ni-W and Co-W systems, that the majority of binary alloys can be successfully modified by a single addition of 0.75Ti-O, 75Zr-0.5C-0.1B. The modified alloys had substantially improved stress rupture lives and ductility. In subsequent alloying of the base Co-35W alloy, it was found that additions of Ti, Zr, C, and Cr refined and modified the base structure and improved properties; however, Mo, V, Ta + Nb, and N_2 adversely influenced both structure and properties. Variations in the casting procedure were felt to have only minor influence on structure and high temperature properties. Generally, the improvement in properties was associated with a refinement of the dendritic structure and a change in the size and morphology of the microconstituents. (STAR)

13148 (N-66-35175) MECHANISMS OF STRENGTHENING AND FRACTURE IN COMPOSITE MATERIALS. Progress Report No. 4, December 1, 1965-June 1, 1966. Tetelman, A. S. (Stanford Univ., Calif. Dept. of Materials Science). 1966. 12p. (NASA-CR-77451). CFSTI $3.00 cy, $0.65 mn.

Theoretical and experimental studies of strength and fracture in various composite materials were conducted. Electron microscope fractography was used to examine the fibrous and cleavage areas of quenched and tempered steels. The strength and fracture behavior of TiC-Mo_2C-Ni composites were determined; and the mechanism of fracture in iron composites of mechanically drilled holes and a bcc metal matrix are discussed. Areas investigated include amount, size of type of particle influence on fracture behavior, sintering treatment influences, and composition influences. (STAR)

13149 (N-66-37572) INVESTIGATION OF ADVANCED HIGH STRENGTH ALLOYS USED IN WEIGHT REDUCTION OF THE SATURN V THRUST STRUCTURE. PHASE I: FEASIBILITY STUDY. Gowen, Edward F. Jr.; Glackin, James J. (Standard Pressed Steel Co., Jenkintown, Pa.). Jan. 8, 1966. Contract NAS8-20158. 51p. (NASA-CR-78303). CFSTI $3.00 cy, $0.65 mn.

This phase was conducted to determine the feasibility of beryllium for high strength blind and semi-blind fasteners. The investigation covered the history of Be fasteners and materials, the present state-of-the-art in the production of Be fasteners and problem areas that may be encountered in the production of Be fasteners. The investigation showed that semi-blind and blind fasteners of Be are feasible with ultimate strength on the order of 75,000 psi and shear strengths on the order of 65,000 psi. A planned approach for the development of these fasteners is presented. (auth)

13150 (NASA-CR-54934) CONTAMINATION EXPOSURES OF COLUMBIUM AND TANTALUM ALLOY SPECIMENS. Final Report, February 25, 1965-June 15, 1966. Fleming, R. B. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). July 15, 1966. Contract NAS-3-4169. 138p.

An investigation was conducted to determine the oxidation rate, or gettering rate for O_2, of Nb, Zr, and Ta alloy specimens under conditions of low pressures and high temperatures. A total of 15 exposures were conducted during the program, with O_2 partial pressures at levels ranging from about 10^{-9} to 5×10^{-4} torr, and temperatures at levels of 885, 950, 980, and 1100°C. The gettering rates were established by measuring the pressure drop across a known flow conductance, from which the O_2 gas mass flow rate (equal to the gettering rate) can be computed. A knowledge of the pressure directly over the specimen, plus knowledge of the gettering rate, can then be used to calculate the sticking factor (that fraction of total molecules striking the specimen, which do not rebound). The sticking factor is the item of primary interest in these experiments. In addition to the 15 exposures, the program included several experiments which were conducted to determine various pressure gage characteristics, and an analysis was made of pressure distribution throughout the system. The scope of the investigation was confined to exposing the specimens to the various environments and documenting the data and experimental conditions. Subsequent evaluation of the exposed specimens by chemical and metallurgical techniques, and reduction of data, were conducted. (auth)

13151 (NRL-6513) METALLURGICAL CHARACTERISTICS OF HIGH STRENGTH STRUCTURAL MATERIALS. Quarterly Report No. 11, April-June 1966. Puzak, P. P.; Lloyd, K. B.; Huber, R. W.; Goode, R. J.; Lange, E. A.; Freed, C. N.; Crooker, T. W.; Judy, R. W. Jr.; Howe, D. G. (Naval Research Lab., Washington, D. C.). Aug. 1966. 91p. CFSTI $3.00 cy, $0.65 mn.

Fracture toughness studies were made on specially melted 18% Ni grade 250 ksi maraging steel and a Cr-Ni-Mo stainless steel. Welding studies on a 12 Ni-5Cr-3Mo maraging steel with 12Ni-3Cr-3Mo and 17Ni-2Co-3Mo filler metal wire are described with the problems associated with developing optimum properties in both plate and weldment being discussed. Results of fracture toughness studies on Ti alloys and Al alloys are presented in which engineering type tests and fracture mechanics techniques are employed. The fracture toughness index diagrams for steels and Ti are presented based upon the correlations developed with the engineering test methods. Preliminary fracture toughness correlation diagrams are presented for Ti alloys based upon fracture mechanics test methods. Results of a study on the low cycle fatigue crack propagation of a 9Ni-4Co-0.25C steel in air and saltwater is discussed and compared to similar data obtained for other steels covering a spectrum of yield strengths. Stress-corrosion-cracking studies were conducted on Ti alloys, Al alloys, and steels. The stress-corrosion-cracking resistance of these alloys is presented in terms of the stress intensity (K_{Iscc}) required to cause crack propagation to occur due to the influence of the environment. A double-pendulum type, shock-free, 2000 ft-lb impact machine has been designed to obtain fracture appearance, tear energy, and dynamic K_{Ic} information on high strength structural metals using a subsize tear type specimen. Design details of this new test tool are presented. (auth)

13152 (ORNL-3795(Pt.3)) A BIBLIOGRAPHY ON TRACER DIFFUSION IN METALS. PART III. SELF AND IMPURITY DIFFUSION IN ALLOYS. Askill, John (comp.) (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Frequency factors, activation energies, and other data for tracer self and impurity diffusion in alloys were compiled from the literature reported between 1938 and December 1965. An authors' index is included. (auth)

13153 (ORNL-3970, pp 6-10) DEFORMATION AND ANNEALING OF METALS. McHargue, C. J. (Oak Ridge National Lab., Tenn.).

Grain-boundary migration rates during annealing of dilute alloys appear to be determined by the drag of a segregated impurity atmosphere, whereas the rate-controlling process in zone-refined metals is the transfer of single atoms across the boundary. In Al-Au alloys, the migration rate for a given composition appeared to vary inversely as the degree of supersaturation. Mechanical twinning does not contribute significantly to the formation of preferred orientation at high levels of deformation in Nb. The reorientation of Nb single crystals during cold rolling was accompanied by deformation-band formation. The presence or absence of such bands strongly influenced the tendency for recrystallization during annealing. (auth)

13154 (ORNL-3970, pp 11-17) DEFORMATION OF CRYSTALLINE SOLIDS. (Oak Ridge National Lab., Tenn.).

The program of basic studies of the deformation of metals and alloys is aimed at a better understanding of the controlling processes during deformation, of the resulting structure, and of the changes due to annealing. The orientation dependence of storage of energy during deformation of Cu crystals was studied. For the first time, sheet-texture data could be transformed into a complete three-dimensional inverse pole figure, which is required for the complete representation. The method has resulted in a very much more complete texture determination for Cu, Al, and brass. Studies have been continued on the rate-controlling mechanisms in deformation of Ta and Ta-alloy crystals. The problem of irradia-

tion hardening and the overshoot in single crystals was analyzed. (auth)

13155 (ORNL–3970, pp 18-20) DIFFUSION IN SOLIDS. Lundy, T. S. (Oak Ridge National Lab., Tenn.).

By use of radioactive-tracer techniques, diffusion coefficients were obtained for Cr in Cr, Cr–20% Ni, and Cr–44% Ni; Ag and Sc in β-Ti; Mn in bcc δ-Mn; and V and Ti in V–Ti alloys at 10% increments over the entire composition range. The mathematical models for diffusion in grain boundaries were reviewed to compare their derivations. Boundary conditions, mathematical statements, and methods of solutions for three published models were considered. (auth)

13156 (ORNL–3970, pp 21-4) DIRECT OBSERVATION OF LATTICE DEFECTS. Stiegler, J. O. (Oak Ridge National Lab., Tenn.).

An etch-pit technique showed the distribution of dislocations near cracks and in slip bands for W deformed at room temperature. A model was developed for correlating cross slip in bcc metals with stress and temperature. The derived expressions suggested that the sudden onset of brittleness as the temperature is lowered may be the result of a sudden decrease in ability to slip on any plane other than the most highly stressed {110}. The bend-yield stress and the brittle-fracture morphology in W are being analyzed. Some results are reported on the microstructure of SAP. A new process for the rapid preparation of transmission-electron microscopy specimens is briefly described. (auth)

13157 (ORNL–3970, pp 25-32) ELECTRONIC PROPERTIES OF METALS AND ALLOYS. Betterton, J. O. Jr. (Oak Ridge National Lab., Tenn.).

The large increase in the electronic specific heat coefficient and the superconducting transition temperature with control of alloyed transition metals Nb, Mo, Re, and Ru depends upon the atomic concentration and not on the electron-to-atom ratio and whether the matrix crystal structure is cubic or hexagonal. This behavior contrasts with alloying from other regions of the transition metals, where the electron-to-atom ratio is a useful parameter, and suggests that a special effect occurs, such as phonon-electron enhancement of the electronic specific heat coefficient. Interstitial impurity additives increased the critical current density of precipitation-enhanced transition-metal superconductors in the systems Nb–Zr, Nb–Hf, and Nb–Ti. Precipitation enhancement of critical current density was observed in systems Ti–Ta and Zr–Ta. By mass spectroscopy of the gas over molten Zr during zone refining, methods were sought to prepare crystals of greater purity for galvanomagnetic investigations. H_2 removal, Ca removal through CH_4 and other hydrocarbons, and a limited amount of O_2 removal through CO_2 and CO would be indicated by the pressures observed. Oxygen pressure dropped below 10^{-13} torr, so Zr could be refined from O_2, and a resistance ratio of 1160 after 25 passes was obtained. Galvanomagnetic tests had shown earlier that the Fermi surface of Zr is closed and compensated. New voltage measurements show leading terms linear in magnetic field and oscillating in sign with field rotation, inconsistent with theory. Experiments with Mössbauer effect following Coulomb excitation were continued with isotopes of Ge and Ni. It was established that for Ge the recoilless fraction in the target is about one-tenth that in the absorber. Investigations of electronic properties of Cu–Ni alloys by measurements of hyperfine splitting and isomer shift were started. (auth)

13158 (ORNL–3970, pp 99-102) DISPERSIONS IN SOLIDS. Hammond, J. P. (Oak Ridge National Lab., Tenn.).

A unique colloid chemical method was developed for effecting oxide particle dispersion hardening in the refractory metals and alloys. Forming a simultaneous colloid between the dispersant and a salt of the matrix assures fineness and uniformity of dispersion in the final alloy. Stable fissile compounds for fueling Th fuels and means for dispersion strengthening their matrix were sought. UB_2 was the only compound stable at 1000°C, although US and UP were unreactive at 800°C. "Splat-cooling" of Th containing 1.3% Be was a new method for promoting substantial elevated-temperature hardening in fabricated alloys. (auth)

13159 (ORNL–3970, pp 136-8) ZIRCONIUM METALLURGY. Picklesimer, M. L. (Oak Ridge National Lab., Tenn.).

In the study of the metallurgy of Zr-base alloys, the examination was continued of the effects of preferred orientation and hydrogen content on the directional precipitation of hydride, the anisotropy of mechanical properties, the development of texture during fabrication, oxidation-corrosion mechanisms, and the anisotropy of oxidation. Techniques were developed for determining the approximate basal pole figure for Zircaloy-2 by Knoop microhardness measurements, the determination of the orientation in space of the basal pole of any single grain of a polycrystalline close-packed hexagonal specimen by polarized light microscopy, and the determination of the hydride and basal pole figures in hexagonal metals by quantitative metallography. (auth)

13160 (ORNL–3970, pp 236-44) ROVER ROCKET NOZZLE MATERIALS. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.).

The short-time tensile properties and joinability of eight alloys were investigated. These are Inconel X-750, Inconel 718, René 62, Hastelloy X, Hastélloy N, Inconel 625, IN-102, and type 347 stainless steel. In addition, the thermal conductivities of Hastelloy X, Hastelloy N, Inconel 625, and Inconel 702 were estimated. These materials are all candidates for nuclear rocket nozzle fabrication. Also, a method for nondestructively testing tapered thin-wall tubes was developed. (auth)

13161 (WCAP–3487-15) HIGH STRENGTH VANADIUM ALLOY PROJECT. Sixth Quarterly Progress Report, June 30, 1966. Pollack, W.; Thomas, K. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3487. 79p. Dep. mn. CFSTI $3,00 cy, $0,65 mn.

An investigation is being conducted to develop high-strength V alloys for application as fuel-element cladding in a liquid-metal-cooled fast-breeder reactor. Parallel efforts are being conducted in the areas of alloy development, creep testing, sodium corrosion and fuel compatibility evaluation, and welding characterization. Forty-five button-melted alloys were processed to sheet and hot hardness and tensile evaluations of them concluded. The bulk of the creep-rupture testing of these alloys was completed. Of the six more promising alloys selected for scale-up to 2½ in. dia ingots, three were rolled to final sheet, while processing of the remaining three is nearing completion. Evaluation of the former by hot-hardness, tensile, and creep-rupture testing is in progress. The corrosion behavior in convection sodium loop tests of an additional 16 alloys, for a total of 32, was evaluated. All alloys continue to exhibit only weight gains. The compatibility of selected V alloys He-bonded to UO_2 fuel was tested, and the results are being evaluated. Preparations are being made to study the compatibility of these alloys when Na bonded to carbide fuels. Welding tests were performed on all alloys, while ductile-brittle transition temperature evaluation is still in progress. (auth)

13162 (WCAP–3677-2) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1967. Contract AT(30-1)-3677. 7p. (EURAEC–1780). Dep. mn. CFSTI $3,00 cy, $0,65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments in the program for fracture mechanics evaluation of reactor vessel steels included design of the calibration capsule, frame design for holding fracture mechanics specimens, and procurement and sectioning of approved materials for pre-irradiation testing. (P.C.H.)

13163 HIGH-VACUUM PURIFICATION OF NIOBIUM AND TANTALUM AND ITS INFLUENCE ON THE ELECTRIC RESISTIVITY. Dinter, Reiner-Joachim (Univ., Goettingen, Ger.). Z. Metallk., 58: 70-5(Jan. 1967). (In German).

Experiments to purify Nb and Ta with respect to interstitial impurities, are described. By annealing in high vacuum, the content of interstitially dissolved impurity atoms could be reduced to about 10 at.-ppM from initially 3800 or 300 at.-ppM, respectively. Nb specimens thus treated did not show a measurable recovery stage of the electric resistivity after plastic deformation and subsequent tempering between room temperature and 360°C, but instead a small continuous decrease in resistivity was observed. Specimens, however, which were treated with O_2 after purification exhibited a pronounced recovery stage between 100 and 200°C. Within the investigated concentration range, the total recovery of residual resistivity at 230°C was found to depend linearly on the oxygen content and amounted to 8.5% of the additional resistivity due to oxygen. Another recovery stage due to nitrogen was found in Nb between 275 and 360°C. These samples, which were exposed to nitrogen only, showed a weak recovery effect in the range from 100 to 200°C. The observed recovery behavior was interpreted by assuming that the introduced impurity atoms migrate to lattice defects in characteristic temperature ranges, thus contributing less to the resistivity than if interstitially dissolved. The resistivity recovery of a purified specimen is approximately 1.6 times larger than the additional resistivity caused by residual impurities. Only about 10% of this latter resistivity will anneal out, as is shown by the results obtained from specimens treated with gas. Thus an interpretation based on the migration of oxygen or nitrogen does not apply in this case. Rather the observed recovery may be due to annealing of structural point defects, which were produced during deformation. (auth)

13164 ELECTRON MICROSCOPIC STUDIES OF FRACTURING IN MOLYBDENUM ALLOYS. Gol'tsev, V. P. (Inst. of Nuclear Power, Academy of Sciences, Belorussian SSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 100-3(1966). (In Russian).

Effects of small quantities of elements on the brittleness and metalloceramic properties of Mo were studied using 0.03 to 1.0 wt % V, Ti, Hf, Zr, La, and Y. The binary alloys contained from 0.02 to 0.16% oxygen, up to 0.04% nitrogen and 0.008% carbon. The results showed that small amounts of Y, La, and Hf changed the brittleness of Mo to a more viscous state due to the binding effects of the impurities. However, large amounts of Hf, La, and Y, as well as additions of V, Ti, and Zr increased the brittleness of the metal. (R.V.J.)

13165 THEORY OF THE ELECTRIC CONDUCTIVITY OF LIQUID METALS. Faber, T. E. (Cambridge Univ., Eng.). Advances Phys., 15: 547-81(Oct. 1966).

A formal theory of the electrical conductivity of liquid metals as a function of frequency is developed. As a necessary preliminary, the nature of the eigenfunctions which describe the conduction electrons in a liquid metal and the factors which control the density of states are discussed. A number of corrections are found to be necessary to Ziman's formula for the dc conductivity, and to Drude's expression for the frequency variation. (auth)

13166 RESISTIVITY OF VERY PURE Th AND Th–RARE-EARTH ALLOYS. Peterson, D. T.; Page, D. F.; Rump, R. B.; Finnemore, D. K. (Ames Lab., Ames, Iowa). Phys. Rev., 153: 701-4(Jan. 15, 1967).

Resistivity data are given for pure Th samples with a resistivity ratio [$\Gamma = \rho_{300°K}/\rho_{4.2°K}$] greater than 1000. At high temperatures, deviations of the resistivity from the Block–Grüneisen relation correspond closely to the anomaly which is found in the specific heat. The resistivity at 300°K is found to be 15.8 μΩ-cm. Th–rare-earth alloys show no resistance minimum of the type discussed by Kondo, to an accuracy of 0.001 μΩ-cm. (auth)

13167 INVESTIGATION OF PLASTIC DEFORMATION OF BERYLLIUM SINGLE CRYSTALS SUBJECTED TO COMPRESSION. Finkel, V. A.; Papirov, I. I.; Tikhinskii, G. F. (Inst. of Physics and Tech., Kharkov). Soviet Phys.-Solid State (Engl. Transl.), 8: 1664-8(Jan. 1967).

Translated from Fiz. Tverd. Tela, 8: 2092-7(July 1966).

An x-ray press-camera for studying plastic deformation of single-crystal and polycrystalline samples in the stressed state is described. The plastic deformation of Be single crystals of reagent grade purity was studied in this apparatus for three different orientations. The x-ray photographs obtained during various stages of deformation are associated with various portions of the deformation curves. On the basis of this investigation, certain conclusions have been reached concerning the mechanism of plastic deformation in Be. (auth)

13168 DISLOCATION MECHANISMS IN SINGLE CRYSTALS OF TANTALUM AND MOLYBDENUM AT LOW TEMPERATURES. Lau, S. S. (Univ. of California, Berkeley); Ranji, S.; Mukherjee, A. K.; Thomas, G.; Dorn, J. E. Acta Met., 15: 237-44(Feb. 1967). (UCRL-16778).

High-purity single crystals of Ta and Mo oriented for (101) [111] single slip were tested in tension over the range of temperatures up to 620°K at two strain rates. Activation energies and activation volumes were determined. Analyses of the data revealed that they were in good agreement with the Peierls mechanism. (auth)

13169 STUDY OF NITROGEN IN A CHROMIUM–YTTRIUM ALLOY. Klein, Mark J. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. Trans. Met. Soc. AIME, 236: 1679-84(Dec. 1966).

The behavior of nitrogen in Cr–0.12 at. % Y was studied in specimens of varying interstitial concentration and thermal history. It was found that soluble nitrogen can be introduced into this alloy by increasing the concentrations of either O or N. For low N concentrations the N in solution was low relative to that in unalloyed Cr. However, the N in solution increased with increasing N concentration, approaching that in unalloyed Cr. When the alloy is supersaturated with N, the N precipitated readily from solution as a chromium nitride. The stress-induced relaxation of N was influenced by internal oxidation or internal nitrification of this alloy. (auth)

13170 ULTRAHIGH-VACUUM EFFECTS ON THE MECHANICAL BEHAVIOR OF MOLYBDENUM. Feuerstein, S. (Aerospace Corp., El Segundo, Calif.); Rice, L. Contract AF 04(695)-469. Trans. Met. Soc. AIME, 236: 1674-9(Dec. 1966).

The effect of low pressures on the flow and fracture behavior of Mo is described. For polycrystalline samples, room-temperature tensile tests indicated greater ductility under 10^{-10} torr than under intermediate pressures up to and including atmospheric pressure (760 torr). Tests conducted at 760 torr under atmospheres of air, dry N_2, and purified Ar exhibited no apparent difference in mechanical properties. Critical tests involving baking in situ as well as those involving single-crystal deformation further implied that the ductility effect was a pressure-dependent phenomenon related only to the fracture process. This dependency is discussed in terms of adsorption and diffusion contributions. (auth)

13171 STRAIN AGING OF TANTALUM. Hendricks, P. L. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Spretnak, J. W. Trans. Met. Soc. AIME, 236: 1657-61(Dec. 1966).

The interstitial atom principally responsible for the yield point and strain aging in electron-beam-melted Ta was identified by analysis of the kinetics of the return of the yield point after an increment of plastic deformation. Two sets of specimens contained two levels of oxygen with very low hydrogen contents and the third set had comparable oxygen and hydrogen contents. The activation energy for the return of the yield point agreed well with that for diffusion of oxygen for the first two sets of specimens. For the third set of specimens, the activation-energy value lies between those for diffusion of hydrogen and for diffusion of oxygen. (auth)

13172 EASY GLIDE IN MOLYBDENUM CRYSTALS. Whitmire, L. D.; Brotzen, F. R. (Rice Univ., Houston, Tex.). Acta Met., 15: 409-10(Feb. 1967).

Results revealing the occurrence of easy glide in Mo crystals were obtained by using direct shear on the (110) [1$\bar{1}$1] system of 0.125-in.-dia electron-beam zone-refined Mo crystals. Flow stress and activation volume of a typical crystal are shown. Easy glide was detected only at temperatures greater than 300°K for a shear-strain rate of 4×10^{-5} sec^{-1}. The extent of the easy-glide region depended markedly on the degree of purity of the crystals. (A.G.W.)

13173 PLASTIC DEFORMATION OF IRON–11 AT PERCENT MOLYBDENUM SOLID SOLUTION ALLOY. Rawlings, R. D.; Newey, C. W. A. (Imperial Coll. of Science and Tech., London). Acta Met., 15: 440-3(Feb. 1967).

Yield and flow data on specimens of Fe–11 at. % Mo were obtained using an Instrom testing machine adapted for compression testing. Change of strain rate tests and tests performed at shear strain rates of 7.14×10^{-4}, 1.43×10^{-4}, and 1.43×10^{-3} sec^{-1} were carried out over a considerable temperature range. Activation volumes were calculated. The results were compared with Dorn and Rajnak's theory for the Peierls' mechanism. A good fit with the theory was obtained below 170°K. Above 170°K considerable deviation from the theoretical curve suggested that the Peierls' mechanism was no longer rate controlling. (A.G.W.)

13174 INTERPRETATION OF FRACTURE SURFACE OBSERVATIONS. Beevers, C. J. (Birmingham Univ., Eng.). Acta Met., 15: 432-4(Feb. 1967).

Experimental evidence on one of the mechanisms by which a dimpled fracture surface morphology can be formed is presented. Specimens of high-purity Zr were fractured at 20°C and –196°C. Direct carbon replicas taken from the fracture surfaces of all specimens showed a dimpled appearance. Observations on etched and polished sections near the fracture surface revealed the presence of partially propagated cracks, which were in general associated with voids. These results indicate that in these particular tests separation occurred by ductile crack propagation and that each dimple represents the extent of propagation of an individual microcrack. (A.G.W.)

13175 ELASTIC PROPERTIES OF THORIATED W–Mo AND W–Mo–Re ALLOYS. Brown, H. L.; Kempter, C. P. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 12: 166-8(Feb. 1967). (LA-DC-8127).

Elastic properties of polycrystalline, thoriated $W_{0.542}$ $Mo_{0.418}$ and $W_{0.513}$ $Mo_{0.331}$ $Re_{0.156}$ were determined at 23°C. In units of 10^6 psi the Young's moduli are 53.86 and 54.72, the shear moduli 20.91 and 21.28, and the bulk moduli 42.30 and 42.56, respectively. The calculated Poisson's ratios are 0.288 and 0.286, respectively. These values agree very well with those calculated from the assumption of molar additivity. The lattice parameters, microhardnesses, and specific electrical resistivities are 3.156 and 3.146 Å, 260 and 306 kg/mm², and 11.2 and 22.0 μΩ-cm, respectively. All of the above values refer to material of theoretical density. (auth)

13176 ELECTRICAL RESISTIVITY OF POLYCRYSTALLINE PRASEODYMIUM BETWEEN 2 AND 325°K. Arajs, S.; Dunmyre, G. R. (United States Steel Corp., Monroeville, Pa.). J. Less-Common Metals, 12: 162-6(Feb. 1967).

The electric resistivity of a polycrystalline Pr sample of high purity was investigated in order to find whether some unusual behavior could be observed at 25°K. The total electric resistivity is shown as a function of the absolute temperature. Magnetic susceptibility studies were made to find an indication for the antiferromagnetic-paramagnetic transition at 25°K. No anomaly that would indicate the Néel point was observed. (M.C.G.)

13177 HIGH-TEMPERATURE STRESS-RUPTURE CHARACTERISTICS OF Mo AND SOME Mo ALLOYS. Flagella, P. N. (General Electric Co., Cincinnati). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 281-8(Feb. 1967).

The stress-rupture characteristics of unalloyed Mo at 2200°C were experimentally determined to be dependent on whether it is arc-cast or wrought sintered material. Three vendor sources of arc-cast Mo gave identical results whereas two sources of wrought sintered Mo gave results which were different from each other and different from each other and different from the results for arc-cast Mo. The differences are attributed to the differences in grain size. The arc-cast material has huge grains (500 μ to 900 μ) whereas the wrought sintered material has relatively fine grains (25 μ to 50 μ) even after 100 hours at 2200°C. Stress-rupture curves for arc-cast Mo from 1600° to 2400°C are presented as well as a plot of stress vs the Larson-Miller parameter. The constant in the L–M expression is determined to be 13.4. Also presented are the stress-rupture data for arc-cast Mo TZM at 2000° and 2200°C. The data indicate that the increased rupture life of TZM over unalloyed Mo is negligible at 2200°C. The stress-rupture data for wrought sintered Mo–50 Re show it to have a rupture life approximately one order of magnitude greater than that for unalloyed Mo at both 1600° and 2200°C. (auth)

13178 THERMAL CONDUCTIVITY OF DYSPROSIUM BETWEEN 1 AND 4°K. Rao, K. V. (Oxford Univ.). Phys. Lett., 24A: 39-40(Jan. 2, 1967).

Measurements on the temperature dependence of the thermal conductivity of Dy between 1 and 4°K are reported. An anomaly in thermal conductivity was observed between 2° and 3°K. (M.O.W.)

13179 MANY-BODY TREATMENT OF SOFT X-RAY EMISSION IN METALS. Rystephanick, R. G. (McMaster Univ., Hamilton, Can.). Phys. Lett., 24A: 67-8(Jan. 2, 1967).

A quantum mechanical many-particle derivation of the enhancement of the soft x-ray emission spectrum in metals, due to interactions between the particles, is presented. (auth)

13180 CARBURIZATION OF NIOBIUM- AND TANTALUM-BASE ALLOYS. McCoy, H. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Less-Common Metals, 12: 139-45(Feb. 1967). (ORNL-P-2368).

A technique was developed for carburizing Nb- and Ta-base alloys by exposure to a gaseous benzene H_2 mixture. The quantity and distribution of C absorbed by the specimen can be controlled by varying the composition of the gas mixture and the temperature of the part to be carburized. Several specimens of Nb–1% Zr and T-III (Ta–8% W–2% Hf) alloys were carburized and tested in creep rupture to demonstrate the strengthening effect of the carbon. (auth)

13181 THERMIONIC EMISSION FROM POLYCRYSTALLINE W–25Re IN VACUUM AND LOW-PRESSURE Cs VAPOR. Dionne, Gerald F. (Pratt and Whitney Aircraft, North Haven, Conn.). J. Chem. Phys., 46: 1212-13(Feb. 1, 1967).

To determine the change in work function when Re is alloyed with W, a set of thermionic-emission experiments was carried out in both vacuum and low-pressure Cs vapor with polycrystalline W and W–25 Re filaments of 5-mil diameter. For the W–25 Re filament, the resistivity and specific current variations with temperature were determined in a separate experiment. (W.D.M.)

13182 PROCEEDINGS OF CONFERENCE ON PHYSICAL BASIS OF YIELD AND FRACTURE, OXFORD, SEPT. 1966. Stickland, A. C. (ed.). Conference Series No. 1, London, Institute of Physics and Physical Society, 1966. 303p. £4 10s. (CONF-660945).

The conference included 38 papers, divided into the following sections: theory, metals, polymers, and miscellaneous materials. Summaries only were given for some papers. The discussions are included. Separate abstracts were prepared for 4 of these papers. (UK)

For abstracts of individual papers see: 13183, 13184, 13219, and 13293.

13183 EFFECTS OF SECOND PHASE PARTICLES ON DUCTILITY. Rosenfield, A. R.; Hahn, G. T. (Battelle Memorial Inst., Columbus, Ohio). pp 47-8 of Proceedings of Conference on Physical Basis of Yield and Fracture. Stickland, A. C. (ed.). London, Institute of Physics and Physical Society, 1966.

Experimental tests were made on Fe, an Fe–Si solid solution alloy, and an Fe–ThO_2 dispersion. It was found that although the dispersion supported almost twice as much stress as the base metal at 77°K, both reduction-in-area and fractographic evidence showed Fe to be brittle and Fe–ThO_2 to be ductile at this temperature. Calculations were extended to a wide range of particle sizes and spacings. The upper limits of strength result when the yield stress exceeds the fracture stress and corresponds to volume fractions below 0.1 to 0.2%. For larger volume fractions the separation between the yield-stress line and the fracture-stress line represents a "margin of safety" that can either be partially or fully dissipated by increases in the yield strength owing to impact loading, solution hardening, triaxiality of stresses, and non-random distribution of particles. (UK)

13184 YIELD-POINT PHENOMENON IN ELECTRON-BEAM-REFINED NIOBIUM. Szkopiak, Z. C. (Univ. of Surrey, London). pp 108-18 of Proceedings of Conference on Physical Basis of Yield and Fracture. Stickland, A. C. (ed.). London, Institute of Physics and Physical Society, 1966.

The yield point and associated parameters were studied in electron-beam-refined Nb containing amounts of oxygen ranging from 150 to 800 ppM, tested at room temperature and at strain rates from 5×10^{-5} to 2×10^{-1} sec^{-1}. The upper yield stress σ_u, lower yield stress σ_y, the yield-point drop $\sigma_u - \sigma_y$, friction stress σ_i, and the k_y parameter measure of dislocation pinning showed a linear relation with oxygen content of the form $\sigma = \sigma_0 + \alpha C$ where σ represents any of the above parameters, σ_0 their value at zero oxygen content, α the increment per one ppM of oxygen, and C is the oxygen concentration in wt ppM. The oxygen dependence of σ_u, σ_y, and σ_i decreased linearly with increase in strain rate, while that of $\sigma_u - \sigma_y$ and the k_y parameter increased linearly with increasing strain rate. The strain-rate dependence of the yield point and associated parameters can be expressed by the equation $\sigma = A + A' \log \dot{\epsilon}$. Over the strain rate studied σ_u, σ_y, and σ_i exhibited three strain ranges for which the values of A and A' are different; $\sigma_u - \sigma_y$ exhibited two ranges and the k_y parameter one. In general the values of A for any parameter and strain-rate range are increased, and those of A' decreased, with increasing oxygen content. The dislocation velocity exponent n, as calculated from the strain-rate dependence of σ_u by $\log \sigma_u = \log B + (1/n) \log \dot{\epsilon}$ shows a relation with oxygen concentration, C ppM, of the form $n = 9.2 + 6.9 \times 10^{-3} C^{1.3}$. It is shown that the yield drop was due to dislocation multiplication and that the k_y parameter represented the critical stress required to operate dislocation generation sources ahead of the Lueders band front. The density of mobile dislocations at the upper yield stress decreased with increasing content of oxygen, while their velocity and the stress corresponding to unit velocity of dislocations increased with increasing oxygen content. (auth)

Structure and Phase Studies

Refer also to abstracts 13123, 13143, and 13147.

13185 (APED-4674) ORIENTATION AND MORPHOLOGY OF $M_{23}C_6$ PRECIPITATED IN HIGH NICKEL AUSTENITE. Wolff, U. E. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Feb. 12, 1965. 23p.

The precipitation of carbides from an alloy containing 33% Ni, 21% Cr, and the balance Fe was investigated electron microscopically by means of extraction replicas and thinned metal foils. Annealing temperatures ranged from 565 to 870°C for up to several thousand hours. $M_{23}C_6$ precipitated in grain boundaries, incoherent and coherent twin boundaries in that sequence. The orientation relationship between carbides and austenite matrix was determined and correlated with the morphology of the carbides and with the type of boundary in which precipitation occurred. In large-angle grain boundaries, as well as in coherent twin boundaries, the carbides were in epitaxy with one of the adjacent grains. These carbides formed sheets of individual flakes with shapes related to the orientation of the boundary. In incoherent twin boundaries, carbides precipitated in ribbons composed of parallel rods. An unidentified subcarbide was found to precede precipitation of $M_{23}C_6$ in these boundaries. The $M_{23}C_6$ rods had a kind of fiber texture with ⟨110⟩ parallel to that long dimension of the rods and ribbon, and with orientations of both of the adjacent twin-related austenite crystals predominant in the texture of the carbide. A hard sphere crystal model was used to discuss epitaxy and morphology of the carbides in terms of free volume and vacancies available in the boundaries. (auth)

13186 (CEA-R-3093) INFLUENCE DE CARBONE SUR LA CRISTALLISATION PRIMAIRE DES ALLIAGES U–Mo DE FAIBLES TENEURS. (Effect of Carbon on the Primary Crystallization of Low Content U–Mo Alloys). Colombie, Michel; Decours, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1966. 44p. (In French). Dep. mn.

The effect of addition of small amounts of C on the primary crystallization of 1.1% U–Mo alloys was studied. The primary γ-crystallization-rate curves, as a function of the C concentration for a given cooling speed, showed a maximum. The maximum decreased from 800 to 500 ppM if the cooling speed was increased. But the maximum disappeared if the cooling speed became too small. The mechanism for the C effect is discussed.

Four methods for preparation of low-C-content U–Mo alloys were investigated: preparation beginning with graphite powder, with molybdenum carbide, with CO_2 bubbling, and with an arc furnace. The arc-furnace method was the only one that gave homogeneous concentrations above 1500 ppM. (J.S.R.)

13187 (CONF-660935-3) STRUCTURE AND CORRELATION IN LIQUID ALLOYS BY X-RAY AND NEUTRON DIFFRACTION. Henninger, E. H.; Buschert, R. C. (Purdue Univ., Lafayette, Ind.); Heaton, LeRoy (Argonne National Lab., Ill.). [1966]. Contracts AT(11-1)-123; W-31-109-eng-38. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Properties of Liquid Metals, Upton, N. Y.

A method for obtaining information about correlation in a liquid or amorphous alloy is presented. The explicit structure in a binary could in principle be determined from three independent diffraction patterns. It is relatively much simpler to measure and analyze the x-ray and neutron intensity patterns and with these alone obtain considerable correlation information, even if more than two atom types are present, by calculating the ratio of the two experimental radial distributions. For the binary the relevance of the ratio derives from the fact that each distribution is a sum of the radial distributions of the three types of atom pairs, each term being weighted by the appropriate product of scattering amplitudes. The structure of the sample can be analyzed by comparing the ratio for any interatomic distance to the values it would have for pure A-A, pure B-B, pure A-B, and random pairing. In a true liquid the results are semiquantitative. In an alloy with well-defined short range order, the correlation of these close pairings can be clearly determined. Results are shown for liquid NaK and vitreous silica. For any alloy the experimental results would serve to test structural models. (auth)

13188 (N-66-37365) FEASIBILITY STUDY OF THE USE OF THERMALLY-INDUCED STRAINING FOR GRAIN REFINEMENT IN RECRYSTALLIZED TUNGSTEN. Final Report. (Arde-Portland, Inc., Paramus, N. J.). [1966]. Contract NASw-1145. 73p. (NASA-CR-78165). CFSTI $3.00 cy, $0.65 mn.

In order to develop techniques for processing W welds in finished hardware, a feasibility study of grain refinement by thermal straining is presented. Activities involved performing metallurgical studies to set up base line data; heating runs to work out the mechanics of fixturing, heating, and instrumentation; calculations to relate the original predictions of cycles to strain more closely to actual heating conditions; and making runs to determine means of eliminating crack formation in specimens. No conclusion was reached as to the validity of this technique, because of the inability of the plasma gun to operate continuously at the high heat flux necessary to achieve test objectives. (STAR)

13189 (NP-16533) THE MICROSTRAIN REGION IN HIGH PURITY REFRACTORY METALS. Quarterly Report No. 3, September 1, 1966–November 30, 1966. Prekel, Heinrich L.; Lawley, Alan; Conrad, Hans (Franklin Inst. Research Labs., Philadelphia, Pa.). Contract Nonr-4434(00). 18p. (Q-B2195-3).

Dislocation velocity measurements at room temperature on Mo single crystals by the etch-pitting method are described. It is shown that the stress dependence of the dislocation velocity obeys the relationship $v = (\tau/\tau_0)^m$, with $m \sim 6.4$ and $\tau_0 \sim 5.5$ Kg mm^{-2}. It is also shown that this relationship can be derived directly from thermal activation theory and that the results support the thermally activated overcoming of the Peierls hills as the rate controlling process in the plastic deformation of Mo. (auth)

13190 (ORNL-3970, pp 54-8) X-RAY DIFFRACTION. Yakel, H. L. (Oak Ridge National Lab., Tenn.).

The crystal structure of Y_2BeO_4 was described. The same unusual threefold oxygen coordination about Be was found as in the previously reported $Ca_{12}Be_{17}O_{29}$. Analyses of structures of other beryllates are in progress. Refinements to both theory and experiment were made in the low-angle x-ray-scattering program. Analysis of space-charge effects in proportional counters and of slit-height corrections to low-angle scattering data has been completed. A relation has been found between the apparently disparate theories of low-angle scattering from precipitating systems proposed by Gerold and by Cowley. Experiments illustrating the advantages of x-ray monochromation by bent pyrolytic graphite with a high degree of basal-plane orientation are reported. Preliminary results predict eventual realization of a monochromator that places as much or more useful power at the experimental sample as may be obtained with an unmonochromated beam. (auth)

13191 (ORNL-3970, pp 231-5) METALLOGRAPHY. Gray, R. J. (Oak Ridge National Lab., Tenn.).

Vacuum evaporation of oxide films on polished metal surfaces provided a new means of revealing microstructures; experimental techniques were developed for routine use of this method. The present state of metallography was thoroughly reviewed and presented as a paper. It was discovered that curing stresses in metallographic mounting material were damaging some braze samples; a means of minimizing this phenomenon, was developed. The effect of specimen preparation on electron-beam microprobe analysis was examined. Techniques of handling ceramic materials were developed and refined. A successful method of polishing and etching CeC_2, which is quite reactive with moisture, was developed. The procedure was similar to that employed for Th and ThC_2–UC_2. It was discovered that the appearance of the pyrolytic carbon coating on microspheres was greatly affected by the method of final polishing. The use of Al_2O_3 in silicone oil revealed the general structure of the coating but made it appear to have low density. The use of 0.5-μ diamond paste in water showed less marked structure but higher apparent density. (auth)

13192 (RT-MET-(66)-1) INFLUENZA DEI TRATTAMENTI TERMICI SULLA STRUTTURA DI LEGHE DI URANIO A BASSO TENORE DI NIOBIO. (Effects of Thermal Treatment on the Structure of Uranium Alloys Containing Niobium). Fizzotti, C.; Masperoni, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 23p. (In Italian). Dep. mn.

A few U alloys containing up to 5 wt % Nb were aged at 550°C after having been continuously cooled at different rates from the γ phase. The change of the structure occurring on aging is described and discussed. Step-annealing in the binary phase fields ($\beta + \gamma_1$), ($\alpha + \gamma_1$), and ($\alpha + \gamma_2$) were also performed and described. A portion of the binary system U–Nb, near the U side, was revised and the obtained results were compared with previous ones. (auth)

13193 (AD-643925) EFFECT OF PRELIMINARY RECOVERY ON THE RECRYSTALLIZATION KINETICS OF DEFORMED METALS. Larikov, L. N.; Zasimchuk, O. E.; Kutikhina, Zh. Ya. Translated from Ukr. Fiz. Zh., 10: 899-905(1965). 10p. (FTD-HT-66-179). CFSTI $3.00 cy, $0.65 mn.

X-ray and microstructural methods were used to study the effects of preliminary annealing on subsequent recrystallization in single crystals of a number of pure metals (Cu, Ni, Nb, W, Mo). After weak deformations preliminary recovery of the samples leads to a delay and, sometimes, even to complete prevention of subsequent recrystallization. Single crystals of metals with body-centered lattices may be deformed by 30% and more without recrystallization during subsequent annealing, provided there is a definite geometry of plastic deformation. It was found that preliminary annealing inhibits subsequent recrystallization owing to polygonization rather than to vacancy rest. After strong (80%) deformations preliminary polygonization did not affect the subsequent course of recrystallization. (P.C.H.)

13194 STRUCTURE AND PROPERTIES OF THE $Nb_3(Sn_xAl_yGe_z)$ PHASE. Ageev, N. V.; Shamrai, V. F. (Baikov Inst. of Metallurgy, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1038-46 (June 1966). (In Russian).

The pattern of the dependence of the microhardness, lattice parameters, and series order on the composition in the investigated cross section of the Nb–Sn–Al–Ge system confirmed the formation of a continuous series of solid solutions between the compounds Nb_3Sn, Nb_3Al, and Nb_3Ge. The alloys high in Al (80 to 85%) possess the greatest regularities and those with high concentrations of Ge (35 to 50%) have the least regularity. The lattice parameters of alloys with a high concentration of Sn change additively with a change in the composition; for alloys adjoining ternary diagrams of Nb–Al–Ge there is a site of synclinal folds. The value for microhardness for alloys with different concentrations of Sn, Al, and Ge changes little (900 to 1070 kg/mm^2). Alloys with high concentrations of Ge, alloyed with Sn, have the highest microhardness (1070 kg/mm^2). The anomalous value of the property in alloys rich in Ge is explained by the low series order for these alloys. (tr-auth)

13195 INVESTIGATIONS OF THE SYSTEMS OF YTTRIUM, SAMARIUM, GADOLINIUM, DYSPROSIUM, HOLMIUM, AND ERBIUM WITH MANGANESE USING THE AMALGAM METHOD. Kirchmayr, Hans Rudolf; Mach, Dominik (Technische Hochschule, Vienna). Z. Metallk., 58: 66-9(Jan. 1967). (In German).

The amalgam process was applied to rare earth (RE)–Mn alloys (RE = Y, Sm, Gd, Dy, Ho, and Er). By a three stage heating process of RE–Mn amalgams mercury-free RE–Mn alloys were formed, to which an equilibrium temperature of 800 to 1100°C has to be attributed. The mechanism of reaction was studied more in detail with the system Y–Mn. The results of x-ray diffraction investigations on the phases $REMn_2$, RE_6Mn_{23} and $REMn_{12}$, present in these systems, are reported. (auth)

13196 USE OF YTTRIUM IN GETTERING OXYGEN AND NITROGEN IN NIOBIUM-BASE ALLOYS. Delgrosso, E. J.; Carlson, C. E. (United Aircraft Corp., Middletown, Conn.). J. Inst. Metals, 94: 363-6(Oct. 1966).

The effects of yttrium additions on nitrogen and oxygen interstitials present in niobium alloys containing zirconium, or zirconium and tantalum, as well as carbon were investigated. Results indicated that as much as 90% of the oxygen and 20% of the nitrogen in arc-melted products were removed. Carbon concentrations was not appreciably altered by the addition of yttrium. Grain-size reductions of 30 to 50% and reductions in the degree of coring in the arc-melted specimens resulted. Secondary phases were identified by x-ray diffraction. (J.G.B.)

13197 ON THE TERNARY PHASES UCoAl, UIrAl, AND UNiAl OF THE C22(Fe_2P) TYPE. Steeb, Siegfried; Petzow, Guenter (Max-Planck-Inst. for Metal Exploration, Stuttgart). Trans. Met. Soc. AIME, 236: 1756-8(Dec. 1966).

During an investigation of the U–Co–Al, U–Ir–Al, and U–Ni–Al ternary systems, three phases were identified, which correspond to the phases UCoAl, UIrAl, and UNiAl, and which crystallized in the C22 type with 9 atoms per unit cell. The lattice dimensions are: a = 6.545, c = 3.915; a = 6.893, c = 3.987; and a = 6.703, c = 4.005Å, respectively. Some relations between uranium-containing ternary phases are discussed. (auth)

13198 SECONDARY RECRYSTALLIZATION IN ALPHA ZIRCONIUM. Higgins, G. T. (Univ. of Liverpool). Trans. Met. Soc. AIME, 236: 1758-60(Dec. 1966).

Secondary recrystallization was observed on annealing iodide Zr at 800°C and the associated changes in crystallographic texture were examined. Pole figures were determined for specimens annealed for 5 min and 24 hr at 800°C. They indicated that the dominant feature of the initial recrystallized texture consisted of basal planes at an angle of $32\frac{1}{2}°$ to the sheet surface, with a $\langle 11\bar{2}0\rangle$ axis lying parallel to the rolling direction. After annealing for 24 hr at 800°C the basal planes were still at an angle of $32\frac{1}{2}°$ to the sheet surface but the $\{10\bar{1}1\}$ pole figure indicated that a $\langle 0\bar{1}0\rangle$ axis now lay in the rolling direction. Thus the grains that developed preferentially possessed orientations different from the dominant component of the primary recrystallization texture, but related to it by a 30° rotation about the c axis. The results were consistent with the growth of grains specially oriented with respect to the main texture of the matrix, such that they possess boundaries of high mobility. (D.H.M.)

13199 ALLOTROPIC TRANSFORMATIONS IN CERIUM. Rashid, M. S.; Altstetter, C. J. (Univ. of Illinois, Urbana). Trans. Met. Soc. AIME, 236: 1649-56(Dec. 1966).

Allotropic transformations in cerium were studied by dilatometric, resistometric, x-ray diffraction, and metallographic techniques. The dilatometric study indicated that, on cooling below 0°C, the high-temperature fcc phase, γ, transformed partly to the hexagonal phase, β, and, on further cooling, to the collapsed fcc phase, α. The amount of β phase present at room temperature was increased by repeated cycling through the α–γ transformation. It was shown metallographically that the γ–β transformation has many characteristics of a martensitic transformation. In contrast to the γ–β transformation the γ–α transformation did not give the manifestation of a shear transformation. Small cellular γ domains of random shape and size collapsed to α in a short time with no apparent coordination with neighboring domains. The confusion in the literature over the existence of more than one high-temperature fcc phase is discussed. Two such phases were reported in the literature and an attempt was made to clarify the situation. Twelve fcc and two hcp structures were shown to be easily reproduced or eliminated. It is proposed that the two "additional" allotropes reported in the literature and fourteen of the phases detected here are not allotropes of cerium but are due to contamination. (auth)

13200 SOME OBSERVATIONS ON BOUNDARIES IN TUNGSTEN. Attardo, M. J. (Brookhaven National Lab., Upton, N. Y.); Galligan, J. M. Acta Met., 15: 395-7(Feb. 1967).

Field ion microscope observations of grain boundary structures in W are reported. In the micrograph shown, the grain boundary essentially consists of two almost straight portions in each of which there is a single jog on each of the (112) planes where they are coincident with a (114) plane. The observations support the suggestion that a macroscopically curved boundary would be, on a microscopic scale, segmented with some preference for straight line segments that follow a particularly low energy configuration. (A.G.W.)

13201 CHARACTERISTICS OF BETA → ALPHA AND ALPHA → BETA TRANSFORMATIONS IN PLUTONIUM. Nelson, R. D. (Battelle Memorial Inst., Richland, Wash.); Shyne, J. C. Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 236: 1725-31 (Dec. 1966).

The $\beta \rightarrow \alpha$ and $\alpha \rightarrow \beta$ transformations in Pu were studied with particular emphasis on the transformation kinetics and microstructure. The kinetic data showed conclusively that the $\beta \rightarrow \alpha$ transformation in high-purity Pu can proceed isothermally with no athermal component. Plastic deformation of the stable β phase retarded the subsequent $\beta \rightarrow \alpha$ transformation. Plastic deformation of the stable α phase accelerated the $\alpha \rightarrow \beta$ transformation; the acceleration was attributed only to residual stresses. The $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ volume changes occurred anisotropically in textured Pu. An apparent crystallographic relationship existed between the parent and the product phases of the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations. Both applied uniaxial compressive stresses and uniaxial tensile stresses raise the starting temperature for the $\beta \rightarrow \alpha$ transformation. A given uniaxial tensile stress favored the $\alpha \rightarrow \beta$ transformation more than an equivalent applied uniaxial compressive stress opposed the transformation. These observations of the $\beta \rightarrow \alpha$ and $\alpha \rightarrow \beta$ phase changes in Pu are consistent with known martensitic transformations. (auth)

13202 LAVES PHASES IN THE SCANDIUM–IRON SYSTEM. Protasov, V. S.; Kripyakevich, P. I.; Cherkashin, E. E. (Lvov State Univ.). Soviet Phys.-Cryst. (Engl. Transl.), 11: 591-3 (Jan.-Feb. 1967).

Translated from Kristallografiya, 11: 689-92(July-Aug. 1966).

Sc–Fe alloys with Fe contents of 20 to 71 at. % were prepared and their structure analyzed by x-ray powder diffraction. The basic structure of the alloys with Fe content of 50 at.% or less, was found to be of the $MgCu_2$ type. For Fe contents larger than 50 at. %, a different line pattern appears which agrees more with the $MgZn_2$ type than with the $MgNi_2$ type. The results indicate that two modifications of the $ScFe_2$ compound exist, dependent on the Fe content. The analogous systems Hf–Fe and Zr–Fe are discussed briefly. (D.L.C.)

13203 SURFACE STRUCTURE OF TUNGSTEN WIRES HEATED BY DIRECT CURRENT IN A VACUUM. Neumann, G. M.; Hirshwald, W.; Stranski, I. N. (Freie Univ., Berlin. Max-Planck-Gesellschaft, Berlin). 11p. (CONF-660640-3). DTIE. Gmelin, AED-CONF-66-187-4.

From International Conference on Crystal Growth, Boston.

The phenomenon of the dc effect is described and it is shown that a crucial point is the formation of an adsorption layer, which alters the sequence of the equilibrium planes of a crystal. (auth)

Radiation Effects

Refer also to abstracts 13141, 13642, and 13643.

13204 (AD-644051) USE OF ELECTRONIC COMPUTERS TO CALCULATE RADIATION DISTURBANCES IN METALS. Orlov, A. N. Translated from pp 288-93 of Deistvie Yadernykh Izluchenii Na Materialy, Akademiya Nauk SSSR, 1962. 12p. (FTD-HT-66-433). CFSTI $3.00 cy, $0.65 mn.

Calculation of the dynamics of formation of radiation disturbances were conducted for models of sections of a fcc grid in the form of parallelepipeds limited by the planes of a cube and consisting of $5 \times 4 \times 4 = 80$ nuclei (446 atoms), $2 \times 6 \times 7 = 84$ nuclei (488 atoms), and $2 \times 9 \times 10 = 180$ nuclei (988 atoms). It was shown that the displacements of atoms in the cubic grid differ from those calculated by the theory of isotropic continuum. It was also established that the interstitial atom at the center of a face-centered cube is unstable. It was found that if a vacancy and an interstitial pair are located along the direction $\langle 100\rangle$, then the minimal distance between them must be at least $2\underline{a}$, where $\underline{a}$ is the grid constant, otherwise annihilation will occur. It was concluded that the threshold energy of formation of a Frenkel pair during collisions in the directions $\langle 100\rangle$ and $\langle 110\rangle$ lies around 25 eV, and for the direction $\langle 111\rangle$, around 85 eV. At low energies the motions of atoms resemble thermal peaks; however, energy transfer in the peak is sharply anisotropic. (M.C.G.)

13205 (BNWL-SA-154) BASIC SWELLING STUDIES. Leggett, R. D.; Bierlein, T. K.; Mastel, B.; Taylor, H. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1964]. Contract AT(45-1)-1830. 76p. (CONF-650904-14). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Radiation Effects, Asheville, N. C.

Small tubular specimens of high-purity uranium (20 ppM Al, 115 ppM Fe, 30 ppM Si, 15 ppM C) and two dilute U-base alloys [(645 ppM Al, 410 ppM Fe, 85 ppM Si, 500 ppM C) and (25 ppM Al, 140 ppM Fe, 95 ppM Si, 400 ppM C)] were irradiated in NaK at controlled temperatures and pressures to burnups as high as 0.4 at. %, at pressures as high as 1000 psi in the temperature range 300 to 700°C. The irradiation behavior was inferred from changes in density and microstructure. High-purity U exhibited drastic swelling in the 400 to 600°C range, essentially no swelling below 350°C, and only minimal swelling at approximately 650°C. The alloy specimens behaved similarly but the magnitude of the swelling was much less. The high Al–Fe alloy swelled less than the low Al–Fe alloy. Swelling in α-U was ascribed to the interaction of defects produced by the fission event rather than the

formation of fission-gas pores. Fission-gas porosity was a major contributor to swelling only above 700°C. Pressure markedly inhibited swelling at 450°C. Four distinct microstructures developed in α-U at particular irradiation temperatures. Below 350°C the structure became severely worked; no cracks, tears, or pores formed. At 400 to 500°C the structure also became worked; severe intergranular tearing occurred and was responsible for the very large swelling observed. At 500 to 600°C the original grain shape was retained; tears at grain boundaries and tears aligned crystallographically within grains formed and accounted for the observed swelling. Above 600°C the original grain shapes were retained, crystallographically aligned tearing no longer occurred, grain boundary tearing diminished in intensity but still accounted for most of the swelling and tiny pores appeared dispersed randomly throughout the matrix. Studies at beta and gamma temperatures indicated that swelling is due to fission-gas porosity and increases rapidly with increasing irradiation temperature above 730°C. Segregation of gas pores at gamma grain boundaries was observed. (auth)

13206 (EURAEC-1728) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 3, April 1–June 30, 1966. (Societe Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Sept. 1966. Contract 074-65-10-TEEI(RD). 11p. (EUR-2900). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Work done in SORIN and in IENGF during the period April 1 to June 30, 1966 is reported. Five irradiations were carried out, one of them, still running, up to an evaluated fluence of 3×10^{19} n (>1 MeV) cm^{-2}. Measurements were also continued on the mechanical properties of unirradiated ASTM A212B steel (killed with Ti or Si or Al) specimens while Ferrovac-E specimens were also tested at different strain rates at room temperature and −80°C. The damage dosimetry program continued; an irradiation container was set up and tested. A first irradiation and a complete characterization of the specimens to be irradiated were done. Irradiation was performed at temperature ≤48°C. Magnetic properties measurements were continued on FeSi specimens. (auth)

13207 (EURAEC-1743) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (≈0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. Progress Report, M-66-875-50005, July 1–September 30, 1966. van Elst, H. C. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague. Metaalinstituut). Oct. 18, 1966. Contract 060-64-11-TEEN. 22p. (EUR-3303). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The embrittlement of 4 pressure vessel steels after increasing neutron radiation fluences between ca 1×10^{18} and ca 0.5×10^{21} $n.cm^{-2}$ at 80°C was determined by performance of the stress wave attenuation test (S.A.T.). Several criteria for indicating the transition temperature, as equally possible at notch impact results, were investigated as to their prediction of the shift in transition after irradiation. (auth)

13208 (IN-1052) AXIAL FATIGUE OF PRE- AND POST-IRRADIATED A 302 B AND A 212 B STEELS. Brinkman, C. R.; Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). Jan. 1967. Contract AT(10-1)-1230. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The axial fatigue properties of A 302 B and A 212 B steels in pre- and post-irradiated conditions at a fluence of 4×10^{17} nvt E > 1 MeV were investigated. For the A 302 B steel in the test region of 10,000 to 100,000 cycles, the fatigue life of the irradiated samples appeared to be reduced in the high strain range and increased slightly in the low strain range so that a crossover in the two curves occurred. For the A 212 B steel, the fatigue lives of the irradiated samples were within the test scatter. Cyclic plastic strain range was found to be the parameter most sensitive to irradiation. The fatigue toughness (total-energy-to-failure) increased as the number of cycles-to-failure increased. Analysis of the data in terms of semiempirical equations showed the data to be in agreement with other investigations. (auth)

13209 (LAC-ER-8811) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Report No. 5, July 21, 1966–October 21, 1966. (Lockheed Nuclear Products, Marietta, Ga.). Nov. 1966. Contract NAS3-7985. 70p. CFSTI $3.00 cy, $0.65 mn.

The effects of irradiation at 30°R on tensile properties of Ti and Ti alloys are reported. Information is included on the effects of interstitial content in Ti-base–5% Al–2.5% Sn on changes due to irradiation, effects of initial heat treatment of Ti-base–6% Al–4% V on changes due to irradiation, and low-cycle fatigue testing of the alloys. The tests were performed under the following environmental conditions: room temperature, unirradiated, 30°R; following irradiation at 30°R to 10^{17} n/cm^2; and 30°R, during irradiation. Test procedures and equipment are described. (J.H.M.)

13210 (N-66-20135) CONTROL SPECIMEN DATA FOR STRUCTURAL MATERIAL IRRADIATION TEST PROGRAM. (Aerojet-General Corp., Azusa, Calif.). Nov. 12, 1964. Contract SNP-1. 476p. (NASA-CR-71020). CFSTI $3.00 cy, $0.65 mn.

Developments in studies on radiation effects on structural materials at cryogenic temperatures are reported. The data presented include mechanical properties of tension and shear at cryogenic temperatures (−423°F), and tensile properties at room temperature. Parent metal and welded and brazed specimens of 18 alloys were tested. These metals include Al alloys A356, 2219, 5456, 6061, 7075, and 7079; Ti alloy A110-AT; stainless steels 304, 321, 347-C 440C, and AM 350; and high temperature alloys A286, Inconel 713 C. Inconel X-750, H-Monel, Hastelloy C, and TZM Mo. The tests were performed to establish reference points for comparison with properties of the same materials after irradiation. After tensile testing, the broken tensile specimens were microscopically examined in the strained and unstrained regions. Optical, electron photomicrographs, and x-ray diffractograms were prepared for future comparison. (STAR)

13211 (N-66-24695) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Final Report. Schwanbeck, C. A. (Lockheed-Georgia Co., Marietta). Jan. 1965. Contracts NAS3-7987; NASw-114. 303p. (NASA-CR-54881; LAC-ER-8434). CFSTI $3.00 cy, $0.65 mn.

Tensile testing was performed at room temperature without irradiation, at 30°R without irradiation, and at 30°R in a high flux zone of a nuclear reactor after 1×10^{17} nvt (E > 0.5 MeV) at the same temperature. The irradiation times varied from 11 to 17 hours. The properties measured were yield strength, ultimate strength, elongation, reduction of area and, in some materials, notched ultimate strength. Al 1099 (–H14) showed previously unreported reduction in tensile yield strength at 30°R unirradiated which was fully recovered with irradiation. The heat treatable high Cu–Al alloys and the Al–Mg–Si alloy 6061 showed a consistent reduction of ultimate strength due to irradiation at 30°R. The high Mg–low Zn–Al alloys gave no indication of serious deterioration of mechanical properties. The Ti alloys exhibited similar cryogenic and irradiation effects. The Ni alloys, Renê 41 and Inconel X, showed significant decreases in notch strength, while K-Monel showed an increase in yield strength and Inconel showed an increase in notch strength. The cryogenic and nuclear cryogenic effects in the austenitic stainless steels appeared to be a function of the austenitic stability. (auth)

13212 (N-66-33386) ANNEALING OF NEUTRON-IRRADIATION-INDUCED CHANGES IN IMPURITY CONDUCTION IN ANTIMONY-DOPED GERMANIUM. Wolf, E. L.; Compton, W. Dale (Illinois Univ., Urbana). [1965]. 15p. (NASA-CR-77037). CFSTI $3.00 cy, $0.65 mn.

Ge doped with Sb in the range of 1 to 2×10^{17} $atoms/cm^3$ exhibits a temperature independent resistivity at less than 10°K. As acceptor states are introduced by irradiation with fast neutrons, it was found that the low-temperature resistivity exhibits an activation energy ϵ_2. Since the magnitude of ϵ_2 depends on the distribution and the number of occupied donors, this parameter is useful for studying the thermal stability of defects that are introduced by irradiation. It is found in these highly doped materials that the motion of charged defects to form neutral complexes does not seem to involve neutral donors. (STAR)

13213 (N-66-34068) AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS. Semiannual Status Report, January 1–June 30, 1966. Compton, W. Dale (Illinois Univ., Urbana. Dept. of Physics). [1966]. 20p. (NASA-CR-77106). CFSTI $3.00 cy, $0.65 mn.

Continuing research on recombination luminescence and tunneling in semiconductors is reported. Studies of the recombination luminescence of optically excited carriers was extended to liquid-He temperatures with a consequent increase in the resolution of the emission bands. Measurements were made on n- and p-type Czochralski-grown Si irradiated with ^{60}Co gamma rays. The ratio of recombination center concentration to γ flux determined by Hall measurements is being investigated. The impurity band formation in the system of Sb donors in Ge was investigated, using a superconducting metal such as Pb or Nb in the junction and using a point contact form of tunneling junction. The study of the thermal stability of radioinduced defects in n-type Ge is reported completed. (STAR)

13214 (ORNL-3970, pp 112-17) MECHANICAL PROPERTIES. Weir, J. R., Jr. (Oak Ridge National Lab., Tenn.).

The investigations have continued to emphasize the effects of neutron irradiation on the mechanical properties of structural alloys. The potential solutions to the problem of elevated temperature radiation damage were outlined. These involve modifying the metallurgical structure by decreasing the grain size, producing the optimum carbide distribution, and introducing small amounts of Ti to the basic type 304 stainless steel composition. Studies of radiation damage to welds and brazes in austenitic stainless steels and nickel-base alloys show that these are also affected by high-temperature radiation damage. Limited data on stainless steels irradiated in a fast reactor (LAMPRE) show that the ductility of type 316L stainless steel is significantly reduced at temperatures above 600°C, whereas the ductility of 17-4 PH steel is reduced only at a temperature around 700°C. Another ferritic alloy whose properties are less sensitive to irradiation is the composition Fe–15% Cr–4% Al–1% Y. Also, the displacement type of damage that is very pronounced in stainless steels at about 250°C results from clusters of defects that are visible in the electron microscope. A reasonable correlation exists between the mechanical properties after irradiation and the structures observed in the electron microscope. (auth)

13215 (SWRI–1228P4-28) INFLUENCE OF NEUTRON IRRADIATION ON THE PROPERTIES OF STEELS AND WELDS TYPICAL OF THE ERR PRESSURE VESSEL. Topical Report No. 4. Norris, E. B. (Southwest Research Inst., San Antonio, Tex.). Jan. 24, 1967. Contract AT(11-1)-1228. 90p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

As a part of the Elk River Reactor surveillance program, a study was made of the effects of neutron irradiation on the tensile, impact, and fatigue properties of steels and welds typical of those in the Elk River Reactor pressure vessel. The test specimens utilized in this study were exposed to neutron dosages equivalent to that which the vessel will receive after 3.0 full power years of operation. The results of tests on irradiated tensile and fatigue specimens are compared to the unirradiated properties. Charpy V notch impact curves were determined for irradiated materials so that the shift in the transition temperature of the ERR pressure vessel could be estimated. (auth)

13216 (EURFNR–129F) STUDY OF THE CREEP BEHAVIOR OF CAN MATERIALS UNDER IRRADIATION. Gast, K.; Kramer, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK–396. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Irradiation tests to be made on can tubes under internal pressure at regulable temperature, in order to obtain information about the resistance of various cladding materials over a period of time, are described. The samples, which include austenitic steels, Incoloy 800, Inconel X 750, Inconel 625 and 718, Ti–V, and Nb–Ti–V, are to be exposed in the BR-2 reactor. Safety factors involved in the tests are discussed. (P.C.H.)

13217 (NP-tr–1467) DESORPTION OF GASES FROM METALLIC SURFACES UNDER ELECTRON BOMBARDMENT. Auslender, V. L.; Minchenkov, G. B. Translated for U.K.A.E.A., Culham Lab., Abingdon, Eng., from Preprint USSR-1049. 16p. (CTO–311). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The desorption of gases from surfaces of two types of Cu and stainless steel under electron bombardment was investigated. The beam electron energy varied in the range from 100–600 eV. The desorption probabilities for different temperatures of the metallic surfaces are plotted and the mass spectra of the desorbed gases are are indicated. (auth)

13218 POSTIRRADIATION CREEP AND STRESS RUPTURE OF HASTELLOY N. Martin, W. R.; Weir, J. R. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 3: 167-77(Mar. 1967). (ORNL-TM-1515).

The creep ductilities of irradiated Hastelloy N at 650°C were determined at several neutron exposures. Elevated-temperature irradiation embrittlement greatly reduces the stress-rupture strength as measured in postirradiation uniaxial stress tests. The reduction in ductility to values as low as 0.4% is due to an irradiation effect related to the process of intergranular fracture. Intergranular cracks, once formed, propagate with greater ease in the irradiated alloy as compared with a sample exposed to a lesser radiation exposure. (auth)

13219 STRAIN-RATE SENSITIVITY OF THE YIELD STRESS OF STEELS. Fearnehough, G. D. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 88-99 of Proceedings of Conference on Physical Basis of Yield and Fracture. Stickland, A. C. (ed.). London, Institute of Physics and Physical Society, 1966. (TRG-Report-1248; JNPC-MWP-SSG/P(66)40).

The dynamic yield stress was calculated from the general yield load of Charpy specimens fractured in an instrumented impact machine. Several mild and low-alloy steels were investigated over a range of temperatures, together with the effects of neutron irradiation. Results showed that, for the unirradiated condition, the high yield stress steels are less strain-rate sensitive than the low-yield stress steels. Irradiation, which normally increases friction stress, did not result in the expected reduction in strain-rate sensitivity which the increase in yield stress would suggest. This indicated that irradiation hardening is due to the presence of relatively small obstacles. The temperature sensitivity of the yield stress was unaltered by irradiation, indicating that irradiation hardening is athermal in nature. (auth)

13220 DEUTERON-IRRADIATION EFFECTS IN Al–4 WT PERCENT Cu. Katz, L. E.; Herman, H. (Univ. of Pennsylvania, Philadelphia). Acta Met., 15: 416-17(Feb. 1967).

Reverted high-purity Al–4 wt % Cu was irradiated with 10.5-MeV deuterons at temperatures near 77°K. Electrical resistance measurements were made by a potentiometric method during aging following irradiation. The resistance initially drops and then levels off, eventually behaving kinetically very much like unirradiated specimens. It is concluded that the irradiation does not generate sites for nucleation of G. P. I zones and that radiation-generated vacancies do not contribute to diffusivity of solute to zones. (A.G.W.)

13221 RADIATION ANNEALING IN DEUTERON-IRRADIATED GOLD, ALUMINUM, AND PLATINUM. Herschbach, K. (Douglas Aircraft Co., Santa Monica, Calif.); Jackson, J. J. Phys. Rev., 153: 689-93(Jan. 15, 1967).

The damage production below 8°K upon radiation with 10- and 20-MeV deuterons was investigated in Al, Au, and Pt by means of residual resistivity measurements. The influence of alloying, cold work, and quenching upon the absolute damage production rate and the radiation annealing was studied. Annealed and alloyed (0.03 at. % Zn) Al showed no radiation annealing, while cold working increased the production rate and produced radiation annealing. Quenched Pt showed an increase in both the damage production and the radiation annealing effect. When the number of quenched-in vacancies equaled the number of defects produced via irradiation, the production curves for annealed and prequenched Pt approached each other very closely. Annealed, alloyed (0.25 at.% Ag), and cold-worked Au specimens all showed radiation annealing, the treated ones about twice as much as the annealed ones, and cold work increased the production rate. The results indicate that the theory of radiation annealing brought forward by Burger et al. (i.e., point defects already present are eliminated by defects created nearby) cannot fully explain the observed phenomena. (auth)

13222 ELECTRON MICROSCOPE INVESTIGATION OF THE HIGH-TEMPERATURE EMBRITTLEMENT OF IRRADIATED STAINLESS STEELS. Rowcliffe, A. F. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Carpenter, G. J. C.; Merrick, H. F.; Nicholson, R. B. 54p. (CONF-660627–13; TRG-Report-1283). DTIE. Gmelin, AED-CONF-66-198-18.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

An electron-microscopic investigation was carried out on three 20Cr–25Ni austenitic stainless steels irradiated at 650 and 750°C in a thermal neutron flux and tensile tested at 750°C, and on an M316L austenitic stainless steel irradiated at 300°C in a fast neutron flux. It is observed that heterogeneous precipitation of bubbles occurs during irradiation at 650°C and that during irradiation at 750°C homogeneous precipitation occurs as well. This behaviour, and the effects of post-irradiation annealing are discussed in terms of the He concentration and the vacancy concentration. It is shown that during high temperature straining, growth of grain boundary bubbles occurs, and that the bubble spacing and the shape of the grain boundary cracks obtained, support the theory that embrittlement is due to the linking up of bubbles that have exceeded the critical size for continuous growth. (auth)

Ceramics and Cermets

Refer also to abstracts 13100, 13158, 13946, 13947, 13969, and 14086.

13223 (ORNL–3970, pp 3-5) CRYSTAL PHYSICS. Clark, G. W. (Oak Ridge National Lab., Tenn.).

The analysis of the effect of interrelated process variables on the growth of UO_2 single crystals by the centrifugal floating-zone technique was continued. The hydrothermal conditions favorable for the growth of crystals of lanthanide oxyhydroxides, ferrates, and hydroxides were studied. A split autoclave incorporating dis-

posable liners and Bridgman seals was devised. From molten-salt solutions, crystals of CeO_2, hexagonal and tetragonal GeO_2, ThO_2, and Y_2GeMoO_8, were grown, and the temperature dependence of the lattice constants of Y_2GeMoO_8, ThO_2, and CeO_2 were investigated over the temperature range 50 to 350°C. Electron-spin resonance of the lanthanides in the crystals were studied. Apparatus for the spectrophotometric study of small crystals was developed. (auth)

13224 (ORNL–3970, pp 91-5) URANIUM NITRIDE. Scott, J. L.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Research and development on UN as a nuclear fuel for high-temperature reactors with high power densities has included studies of synthesis with high purity, pellet fabrication, effects of Mo, W, Th, O, and C on the structure of UN, and the vaporization of UN at low temperatures. Pertinent data and interpretations are presented. (auth)

13225 (ORNL–3970, pp 103-11) FUEL ELEMENT DEVELOPMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Thermochemical deposition processes are being utilized to prepare fuel compounds and refractory alloys from volatile halides. UO_2 powder was prepared from UF_6 in continuing studies and from UCl_5 as a method of direct conversion of the product of the chloride volatility process. Solid UO_2 coatings were deposited on ThO_2 pellets to form a fissile-fertile combination having a potential reprocessing advantage. Deposition of W–Re alloys has continued. Greatly improved uniformity of composition was achieved by deposition at higher temperatures than used previously. The intermetallic compound UAl_3 was successfully fabricated into Al-base fuel elements for irradiation to high burnup in the Oak Ridge Research Reactor. Swelling that occurred during vacuum degassing of UAl_3–Al compacts for Advanced Test Reactor elements was related to UAl_3 content and degassing temperature. Al-base miniature test plates containing U_3O_8 or Nb-coated UO_2–15% ZrO_2 fuel particles were irradiated to burnups up to 1.7×10^{21} fissions/cm^3 at cladding-film interface temperatures of 240 to 265°C without evidence of failure. (auth)

13226 (ORNL–3970, pp 150-63) GAS-COOLED REACTOR PROGRAM. Coobs, J. H.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Techniques are being developed for fluidized-bed coating of particles and preparing and testing pyrolytic-C-coated particles and fueled-graphite elements containing such particles. The technology for deposition of coatings from CH_4 was extended to larger equipment and to the coating of larger (~500-μ-dia) fuel particles. Techniques were also developed for depositing and characterizing low-density (<1 g/cm^3) coatings from C_2H_2. Under heat treatment and irradiation, coated oxide fuels were stable and performed at least as well as if not better than coated carbides. Predictions based on a mathematical model for coated-particle behavior agreed well with actual results of a recent survey irradiation experiment. The model has also been valuable for planning further irradiation experiments and for optimizing the thickness ratios of two-layer coatings. Techniques were developed for depositing an optimum coating on oxide fuel particles and about 1.5 kg of coated $(Th,U)O_2$ microspheres were prepared for a cooperative irradiation experiment in the Dragon Reactor in England. Heat-transfer analyses of the recent series of irradiation experiments on 6-cm-dia fueled-graphite spheres were also performed to correlate heat-generation rates with measured temperatures. Two processes for fabricating fission-product-emitting fueled-graphite elements are being evaluated as well. Other supporting activities included two experiments at higher temperatures on the creep behavior of graphite under irradiation. Results were consistent with a model for irradiation-induced creep and indicated that if the creep-rate coefficient is such that the stress level does not exceed the fracture stress, very large creep strains (>2%) may be accommodated. The available thermodynamic data for ceramic nuclear fuels were analyzed and correlated. The metallurgical behavior of stainless steel and Inconel nozzles designed for temperature measurement in the EGCR was monitored in a series of mockup tests. In addition, the failure of a 42-in.-dia stainless steel bellows at the EGCR was analyzed. (auth)

13227 (ORNL–3970, pp 209-22) THORIUM UTILIZATION. Douglas, D. A. Jr. (Oak Ridge National Lab., Tenn.).

The activities reported involve characterization of the fuel, testing of the fuel under irradiation, and the development of processes for fabricating fuel elements prototypic of designs useful for power reactors. Since the ^{233}U bred from Th carries α and γ activity, personnel must be shielded during processing steps. An $8,000,000 research facility in which pilot-scale processes can be demonstrated was designed and will be completed in December 1966. Remotely operated equipment is under development and will be installed and jointly operated. The equipment will be designed to prepare and encapsulate U and Th compounds in a graphite matrix for use in high-temperature gas-cooled reactors. Work was done to optimize the most critical step in the fabrication process, that of placing a carbon coating on microspheres of UO_2 and ThO_2. The pyrolytically deposited C must meet several density and anisotropy requirements in addition to specifications for sphericity and thickness. The significant process variables in a fluidized-bed coater have been identified and are being quantified so that a completely automatic system can be designed. As an alternate approach to the problem, a heated rotating drum could be employed as a coating system. Much larger charges of particles are possible in such a device, but the low efficiency of the gas-solid contact is a major obstacle that has not yet been solved. Although the concept of using carbon-coated oxides has proven very satisfactory, the desire to use part of the fuel in the carbide form persists. Although the carbide can be made by mixing of sols, a higher density product can be achieved by the process of solid-solid conversion demonstrated last year. A pilot-scale version of the process has been designed and fabricated. The irradiation program has two objectives. One is to explore the capabilities of ThO_2-base fuels so that their full potentialities can be utilized by designers, and the second is to proof test the products from the processes and equipment designed for remote operation. Most of the accomplishments are related to the first objective. ThO_2-base fuels are stable in performance at exposures of over 1000 reactor full-power days. Successful tests were completed with heat ratings of 1000 W/cm. It is concluded that ThO_2-base fuels have marked superiority to UO_2 fuels in reactivity control and structural stability at very high heat ratings. Irradiation of coated microspheres of sol-gel-derived fuel is a joint undertaking with the ORNL Gas-Cooled Reactor Program. Results indicate that sol-gel-prepared fuels perform equivalently to ceramics processed by older methods. Carbon-coated oxide fuels have performed satisfactorily despite thermodynamic instability. Sol-gel techniques provide extra degrees of flexibility in the forming of ceramic bodies. In the gel state, extrusion without the use of plasticizers has been demonstrated. Packing of preselected sized microspheres to 85% of theoretical density in small-diameter tubes has been accomplished with very low-energy vibration. A basic study of the sintering and grain growth of ThO_2 and UO_2 produced by the sol-gel process uses differential thermal analyses and hot stage microscopy. Although no simple law seems to describe the rate effects observed, shrinkage and crystal growth are evidently related to crystallite size. (auth)

Corrosion and Erosion

Refer also to abstract 14120.

13228 CATALYTIC EFFECT OF MAJOR IMPURITIES ON GRAPHITE OXIDATION. Heintz, E. A.; Parker, W. E. (Speer Carbon Co., Niagara Falls, N. Y.). Carbon, 4: 473-82 (Dec. 1966).

The oxidation of graphite in air in the presence of 0.1 mole per cent of transition metals and inner-transition metal oxides over the temperature range 600° to 700°C was studied. For the first-row transition metals, Ca through Zn, the activation energies are at a minimum for Ca, Mn, and Zn. The second-row transition metals, Sr through Cd, show apparent minima in the activation energies for Sr, Tc, and Cd. These minima are typical of the double humped curve usually seen for the (n–1)d level in which 0, 5, and 10 electrons impart unusual stabilities to the divalent state. The third-row transition metals, Ba through Hg, expectably exhibit no such correlation between activation energy and atomic number. In the case of the first and second-row transition metals, it is postulated that the divalent state of the metal enters into the oxidation mechanism of the graphite in a manner similar to that proposed by Long and Sykes. The third-row transition metals enter into the oxidation mechanism via their most stable oxidation state, which may not be the divalent state. The addition of the oxides of the lanthanides results in similar trends in that the activation energies are found to be at a minimum for La, Eu, Gd, Yb, and Lu. These minima are typical of elements possessing a (n–2)f level in which 0, 7, and 14 electrons impart unusual stabilities to the trivalent state for all lanthanides except Eu and Yb where the divalent state can be stabilized. These metals are postulated to enter into the oxidation mechanism in the Long and Sykes manner via the trivalent state except in the two cases where the divalent state possesses enhanced stability. (auth)

13229 THE EFFECT OF DIFFUSION AND BULK GAS FLOW ON THE THERMAL OXIDATION OF POROUS CARBONS. II. DIFFUSIONAL EFFECTS IN GRAPHITE AT HIGH TEMPERATURES. Hawtin, P.; Gibson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 4: 489-500 (Dec. 1966).

The variation with temperature and oxygen concentration of the

oxidation rate of large tubular specimens of graphite exposed to oxidizing gas on the bore surface was examined. Temperatures in the range 550 to 675°C and oxygen concentrations between 2.5 and 20.8 per cent were studied. Under these conditions the overall rate of reaction is controlled by the rate of in-pore mass transport. A previously reported mathematical model is extended to interpret these results. The experimental results yield an apparent energy of activation of 25.0 kcal/g atom and an apparent order of 0.81. Calculations based on the extended model give a true energy of activation for the graphite–oxygen reaction of 48.6 k cal/g atom and an order of reaction of 0.62. (auth)

13230 COMPLEX TEMPERATURE DEPENDENCE OF THE OXIDATION OF PYROLYTIC GRAPHITE BY CO_2. Ladd, I. R.; Walsh, P. N. (Union Carbide Research Inst., Tarrytown, N. Y.). Carbon, 4: 539-41(Dec. 1966).

The maximum-minimum phenomenon was observed in the oxidation of pyrolytic graphite by CO_2. The experiment was performed using an arc-image stagnation-flow reactor in which a high-velocity stream of gas is impinged on the heated face of a flat sample. The rates were determined from before-and-after measurements of the thickness of the sample at the center of the area where the gas impinged; the temperature was measured at this point while the reaction was proceeding. The measured rates are characteristic of reaction in the C-direction. Data are plotted for the temperature dependence of the rates of graphite–CO_2 reaction and of graphite vaporization. Information is also included on edge profiles of graphite samples oxidized in 400-torr CO_2 flowing at a nozzle-exit velocity of 2650 cm sec^{-1}. (J.H.M.)

13231 REACTION OF ALUMINA WITH CESIUM VAPOR. Higgins, J. K. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc., 65: 643-59(Dec. 1966). (AERE-R-4781).

The attack of Cs vapor on high-purity single-crystal and polycrystalline Al_2O_3 and on material containing added impurities (Cr_2O_3, SiO_2, TiO_2, NiO, and MgO) was studied at 600°C. In general the more-porous sintered aluminas reacted more rapidly than the single crystals and the low-porosity Lucalox-type materials. Neutron irradiation increased the attack in all cases, causing deep Cs penetration into high-porosity samples. The pitting attack observed on the single crystals was thought to be due to the presence of localized SiO_2 and BaO impurities, and the increased reaction and penetration of the irradiated polycrystalline materials to be due to an increase in porosity resulting from radioinduced lattice expansion. (auth)

13232 PROTECTION OF BORON CARBIDE AGAINST OXIDATION AND REACTION WITH VARIOUS MATERIALS AT 1200°C IN AIR ATMOSPHERE. Sazonova, M. V.; Komarova, G. N. Zh. Prikl. Khim., 39: 2662-9(Dec. 1966). (In Russian).

A complex silico-silicide-boride-oxide coating was developed for protection of boron carbide against oxidation and contact with quartz, corundum, BeO_2, and EI-435 ($MoSi_2$) and EI-437 (C–Fe) alloys in atmosphere at 1200°C for over 300 hr. The physicochemical reactions taking place between the silico-silicide-boride-oxide coating and its components, the backing material, and gas media during fusing of the coating on the boron carbide had decisive effects on the process of formation and protection properties of the coating. (R.V.J.)

13233 REACTION OF GRAPHITE FILAMENTS WITH HYDROGEN ABOVE 2000°K. Clarke, J. T.; Fox, B. R. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Chem. Phys., 46: 827-36(Feb. 1, 1967). (BNL-10399).

The reaction rate of graphite and H was measured between 2000 and 3400°K and pressures of 0.01 to 1.0 atm using a heated filament. At the lower temperatures and higher pressures, the reaction occurs on the surface and its rate is proportional to the H pressure and the K_D where K_D is the dissociation constant of H_2. At high temperature and low pressure, the reaction occurs in the vapor phase and is proportional to the sublimation rate of graphite. The sublimation temperature of graphite as a function of C to H ratio was experimentally investigated at 0.1 atm and shown to agree with the estimated thermodynamic calculations. (auth)

Preparation and Fabrication

Refer also to abstracts 12433, 13103, 13129, 13133, 13143, and 13257.

13234 (COO-1591-1) IMPURITY EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIUM AND ALUMINUM OXIDES AT ELEVATED TEMPERATURES. Technical Progress Report, April 1, 1966–December 23, 1966. Gordon, Ronald S. (Utah Univ., Salt Lake City. Inst. of Materials Research). Contract AT(11-1)-1591. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and construction of a vacuum hot-press and two high temperature creep testing facilities are described. Initial exploratory experiments have been conducted on the hot-pressing of pure and doped (Fe_2O_3) MgO and the creep of pure dense (or nearly dense) hot-pressed MgO. Pure and doped (Fe_2O_3) MgO specimens have been hot-pressed to theoretical density at pressures between 20,000 and 35,000 psi. and temperatures between 1040 and 1260°C. Preliminary results from the hot-pressing and creep of dense (or nearly dense) hot-pressed MgO indicate that grain growth can take place in significant amounts below 1300°C. An analysis into the role of a changing microstructure (grain growth) on the creep process in MgO is being undertaken. In addition, the effect of a small amount of porosity on grain growth during creep is being studied. (auth)

13235 (EURAEC-1600) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 13, October 1–December 31, 1965. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). [1966]. Contract 054-64-4 TEEB. 15p. (EUR-2818; R-2366). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Two methods are described for preparing ZrO_2 foils suitable for electron microscopy in transmission. One is based on the recrystallization of detached oxide films formed on the annealed metal. The second uses electropolished metal foils, which are oxidized in the electron microscope by beam heating. A special holder was designed for thinning disk specimens by the jet technique. This holder can be used for jet-polishing disks of any metal. The oxidation was followed by a transformation from the tetragonal to the monoclinic phase. Some attention is paid to this transformation. (auth)

13236 (N-66-19038) ELECTROPHORETIC DEPOSITION OF GRADATED OXIDATION-RESISTANT COATINGS ON TANTALUM-10 TUNGSTEN ALLOY. Campbell, P. F.; Gebler, K. A.; Ortner, M. H. (Vitro Labs., West Orange, N. J.). June 1965. Contract NAS1-3533. 93p. (NASA-CR-66068). CFSTI $3.00 cy, $0.65 mn.

Experimental equipment was successfully tested for the preparation of two-component electrophoretic coatings which are continuously gradated in composition over a thickness of 4 to 8 mils. A variety of intermetallic compounds and refractory oxides were screened as pellets and as coatings for potential use as gradated coatings for the protection of Ta–10W from oxidation at temperatures above 3000°F. Gradated coatings consisting of $MoSi_2$–CaO-stabilized ZrO_2 and WSi_2–2%TiO_2/CaO-stabilized ZrO_2 were chosen for application to test specimens. Tensile specimens, leading edge specimens, and coupons were coated with each of the chosen systems. (auth)

13237 (N-66-24970) TUNGSTEN CLADDING OF URANIUM-ZIRCONIUM CARBIDES BY VAPOR DEPOSITION. Lindgren, J. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 8, 1963. Contract NAS3-2532. 21p. (NASA-CR-74685; GAMD-4220). CFSTI $3.00 cy, $0.65 mn.

Tungsten cladding of UC–ZrC specimens of compositions varying from pure UC to 30 at. % UC-70 at % ZrC has been successfully accomplished. The carbides were found to be extremely reactive in the vapor deposition atmosphere; this required that the gases introduced must be of high purity, and the temperature of initial plating must be kept as low as is practicable to minimize damage to carbides and produce a seal coat. The temperature may then be raised for encapsulation in order to increase the coating rate and enhance the gap bridging capability of the deposition process. (auth)

13238 (N-66-34066) GRAPHITE–METAL COMPOSITES. Final Report, August 1, 1965–July 31, 1966. Harada, Y. (IIT Research Inst., Chicago, Ill.). Aug. 1, 1966. Contract NASr-65(09)). 110p. (NASA-CR-77114). CFSTI $3.00 cy, $0.65 mn.

Hot-pressed metal carbide–graphite composites, incorporating carbides of Ti, Zr, Hf, V, Nb, Ta, Mo, or W with compositional ranges of up to 90 wt. %, were studied. Processing temperatures varied from 2600 to 3200°C and the effects on physical and mechanical properties up to 2800°C were determined. Needle cokes were found to be preferable to spherical-particle graphite sources in achieving rapid densification. At 50 wt. % metal level in any system, hot pressing just below the eutectic temperature produced composites having room temperature strengths of over 10,000 psi. The metal phase enhanced ordering of the graphite phase, and improved bonding occurs through liquid-phase sintering and/or diffusion bonding. High-temperature behavior is related to the liquification temperature. An essentially linear relationship between electric resistivity and flexural strengths is reported. (STAR)

13239 (NYO-1710-66) RESEARCH ON GRAPHITE. Summary Report, April 1, 1966–March 31, 1967. Walker, P. L. Jr.; Palmer, H. B.; Diethorn, W. S.; Kline, D. E. (Pennsylvania State

Univ., University Park). Dec. 20, 1966. Contract AT(30-1)-1710. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: carbon formation and graphitization; gas-graphite interaction and solid state experiments; mechanism of fission gas diffusion in graphite; and dynamical mechanical properties of carbon and graphite. (P.C.H.)

13240 (ORNL-3970, pp 33-5) PHYSICAL CERAMICS STUDIES. Morgan, C. S. (Oak Ridge National Lab., Tenn.).

The compressive-creep deformation of thoria exhibited three modes: brittle fracture at high stress, a macroscopically ductile viscous creep at low stress, and an intermediate mode that exhibits some ductility on a macroscopic scale. Ledge and pore formation at grain boundaries during compressive creep have been investigated. Study of the densification kinetics of sintering powder compacts has been extended to five additional oxides. As in the case of ThO_2, the densification kinetics indicated that the initial sintering is not compatible with diffusion-controlled processes. The progressive geometric changes occurring in a sintering powder mass are being studied, and a mathematical model to describe the process is being constructed. (auth)

13241 (ORNL-TM-1649) PYROLYTIC CARBON DEPOSITED FROM PROPANE IN A FLUIDIZED BED. Beatty, Ronald Lee (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Tennessee Univ., [Knoxville].

A study was made of the influence of process variables on density, degree of preferred orientation, crystallite size, and deposition rate and efficiency of pyrolytic carbon coatings deposited in fluidized beds. The process variables employed were deposition temperatures from 1200 to 1900°C and propane supply rates from 0.05 to 3.2 cc per min per cm^2 of surface area being coated. An additional variable, total gas flow rate, was examined at deposition temperatures of 1300 and 1700°C at a propane supply rate of 0.2 cc per minute per cm^2. In addition to the fluidized substrates (450-micron thoria particles and three-sixteenths-inch diameter graphite disks) used, a stationary axial probe was immersed in the fluidized bed and coated in each experiment. The maximum coating density (2.1 g per cc) was obtained at a deposition temperature of 1200°C. The density decreased to a minimum of about 1.45 g per cc at 1500°C and increased again with increasing deposition temperature. High propane supply rates yielded isotropic coatings at all deposition temperatures. The coating deposition rate increased with higher temperature and with higher propane supply rate. Deposits formed on the stationary axial probes showed that at low temperatures the coating rate is fairly uniform along the axis of the fluidized bed. At higher temperatures most of the coating is deposited in the lower part of the fluidized bed. The most promising set of coating conditions found was the lowest deposition temperature examined, 1200°C, and the highest propane supply rate used, 3.2 cubic centimeters per minute per square centimeter. The coating produced under these conditions had a density of 2.0 grams per cubic centimeter and an anisotropy factor of one. The deposition rate was approximately ten microns per minute. (J.H.M.)

13242 (RFP-863) CHARACTERISTICS OF URANIUM OXIDES PRODUCED BY THERMAL AND OXYGEN-ION BOMBARDMENT REACTIONS. Larson, Donelly T.; Taylor, Norman W.; Terada, Kazuji (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 30, 1967. Contract AT(29-1)-1106. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The characteristics of oxides prepared on U by thermal and oxygen-ion bombardment reactions at 50 and 100°C were observed utilizing ellipsometry, high energy electron diffraction (HEED), and x-ray diffraction techniques. For each oxide prepared, oxide thickness as a function of time was observed. The index refraction at 5461 Å determined from ellipsometer measurements of the thermal oxide is (2.5 − 0.5i); and the index of refraction for the ion-bombardment oxide is (2.5 − 0.4i). The oxides produced by ion bombardment were less crystalline than those produced thermally. (auth)

13243 (STI-PUB-21/21) URANIUM CARBIDES, NITRIDES AND SILICIDES (1963-1965). Bibliographical Series No. 21. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1966. 190p. IAEA: $4.00; Austrian Schillings 104,-; £1.8.3; F Fr 19,60; DM 16,-.

References (720) are given to U.S. and foreign journals, books, reports, and patents published from 1963 through 1965. Abstracts are included for most references. Separate author and subject indexes are given. (P.C.H.)

13244 THORIA SINGLE CRYSTALS GROWN BY VAPOR DEPOSITION IN A SOLAR FURNACE. Laszlo, T. S.; Sheehan, P. J.; Gannon, R. E. (Avco Corp., Wilmington, Mass.). J. Phys. Chem. Solids, 28: 313-16(Feb. 1967).

A solar furnace capable of heat fluxes corresponding to a blackbody temperature as high as 4900°K was used successfully to grow ThO_2 crystals from the vapor phase. This was accomplished by heating a small area of a polycrystalline ThO_2 rod to temperatures well above its melting point until profuse vaporization was observed. The vapors condensed around the molten crater forming single crystals with well-defined crystal habits as well as clearly defined dendrites. The preferred directions of growth were determined by x-ray diffraction analysis. This crystal growing technique also yields crystals of very high purity since the process involves a fractional condensation. The experimental technique and apparatus are described. Laue diagrams of the single crystals and lattice parameters obtained from the powder pattern are also given. (auth)

13245 SINTERING CHARACTERISTICS AND PROPERTIES OF PuS AND PuP. Kruger, O. L.; Moser, J. B. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 49: 661-7(Dec. 1966).

The compounds PuS and PuP were prepared by high-temperature homogenization of the product from the reaction of H_2S or PH_3 gas with partly decomposed plutonium hydride. Studies of sintering characteristics of pellets fired in vacuum and in an argon atmosphere showed that these materials can be sintered to densities slightly greater than 90% of theoretical. The sintering process appears to be complex due to changes of mechanism with increasing temperature. Weight loss data indicated that PuP has a higher effective vapor pressure than PuS but under conditions of fuel irradiation (1 atm pressure of inert gas) PuP has a much lower rate of vaporization. Microstructural examinations and lattice constant measurements verify that monosulfide and monophosphide can exist as substoichiometric compounds. Curvature of the sulfur-rich phase boundary toward greater sulfur solubility at high temperatures is indicated from the x-ray data. Density, melting point, thermal expansion, microhardness, Seebeck coefficient, electrical resistivity, thermal diffusivity, heat capacity, and thermal conductivity are reported. (auth)

13246 PREPARATION AND ANALYSIS OF PRASEODYMIUM MONOPHOSPHIDE. Mironov, K. E.; Vasil'eva, I. G.; Sinitsyna, E. D. (Inst. of Inorganic Chemistry, Academy of Sciences, Novosibirsk, SSSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1315-16(July 1966). (In Russian).

PrP was synthesized by reacting phosphine with $PrO_{1.83}$. It was found that in the formation of the product of stoichiometric composition PrP, a major role is played by the ratio of the oxide to phosphine. At a 3- to 4-fold excess of phosphine, x-ray diffraction and chemical analysis showed the product to contain 80 to 85 wt % Pr and 0.5 to 3 wt % P. PrP begins to form only when phosphine is present in a 10-15-fold excess; a homogeneous phosphidization product is obtained at a 100-200-fold excess of phosphine. The content of Pr and P in the product as a function of the temperature and duration of the experiment was determined. PrP of stoichiometric composition is obtained in highest yield at 1300°C when the reaction lasts 1 hr 15 min to 1 hr 20 min. Chemical analysis of this product showed it to contain 18.1 wt % P and 81.7 wt % Pr. X-ray diffraction confirmed the formation of PrP (a = 5.87 Å) and the absence of other phases therein. (ATD)

13247 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM CARBIDE. Williams, Neville Ronald (to United Kingdom Atomic Energy Authority). British Patent 1,052,084. Dec. 21, 1966. Filed Apr. 27, 1964.

A process for the preparation of uranium carbides or for the preparation of U and other metal mixed carbides, e.g., UC–ZrC, consists of mixing U_3O_8 with C to give a mixed powder, compacting the powder, and heating the compact to a temperature in the range from 1300 to 2000°C. The heating may be carried out in a vacuum furnace until the pressure is finally reduced to <0.05 μ, or the heating may be carried out under a flowing atmosphere of an inert gas. The powders may be mixed either wet or dry, but if wet powders are used, they must be filtered and dried in air at 100 to 150°C. (B.L.M.)

13248 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF NUCLEAR FUEL MATERIALS. McLaren, John Robert (to United Kingdom Atomic Energy Authority). British Patent 1,053,786. Jan. 4, 1967. Filed June 12, 1964.

A process is described for the production of sintered bodies of UN or UC–UN containing the corresponding Pu or Th compound for use as a fuel body for fast and advanced thermal reactors. A powdered UN or UC–UN having substantially all the particles in the size range from 0.1 to 5 μ is used as a starting material. The powder must have a N or N plus C content in the range from 48 to 52 at. % and an O content below 1 wt %. The powder is compacted into pellets, and the pellets are sintered in an inert atmosphere containing less than 10 ppM by weight of O and less than 10 ppM by weight of water vapor. If a mixed carbide is to be produced, a

proportion of PuN, ThN, PuC, or ThC powder having the same size and purity specifications as the UN is mixed with the UN prior to compaction. (B.L.M.)

13249 METHOD AND APPARATUS FOR VIBRATORY COMPACTION. (to United States Atomic Energy Commission). British Patent 1,051,954. Dec. 21, 1966. Priority date Apr. 8, 1964, United States.

A method is described for vibratorily compacting masses, such as spheres, of varying diameters to produce a uniform configuration. It is particularly applicable to the compaction of nuclear fuel and blanket materials into tubes, plates, or other such shapes. A selected size range of particles of the ceramic material are subjected to axial vibration within a container until a close-packed configuration is attained. A screen is provided for exerting pressure for maintaining the particles in the close-packed configuration while a smaller size range of ceramic particles is introduced. During introduction of smaller particles, the container is subjected to both axial and radial vibration. The diameter of the smaller size particles should be less than one-quarter the mean diameter of the other particles. (B.L.M.)

13250 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF CARBIDES FOR NUCLEAR FUEL MATERIAL. Russell, Lewis Eric; Harrison, John David Lawrence (to United Kingdom Atomic Energy Authority). British Patent 1,051,035. Dec. 14, 1966. Filed May 7, 1963.

A method for the manufacture of UC or mixed UC–PuC comprises intimately mixing together the respective dioxides with graphite and reacting the mixture at a temperature in excess of 1500° in a stream of flowing Ar containing <20 ppM by weight of water vapor and <20 ppM by weight total oxygen-containing impurities. The carbide product is subsequently crushed, milled, pressed, and sintered in purified Ar. (B.L.M.)

13251 PROCESS FOR THE PREPARATION OF BERYLLIUM OXIDE AND PRODUCTS THUS OBTAINED. Baur, Alain; Lecocq, Rene (to Commissariat a l'Energie Atomique). British Patent 1,052,228. Dec. 21, 1966. Priority date Dec. 11, 1963, France.

A process is described for the preparation of beryllium oxide by decomposition of the hydroxide in a closed vessel in a water-vapor-saturated atmosphere by heating to 225°C. The steam pressure of the decomposition water is higher than the saturated steam pressure of the additional water being introduced. (B.L.M.)

13252 PROCESS FOR THE FABRICATION OF BODIES FORMED BY DISPERSION OF REFRACTORY MATERIAL WITHIN A PYROCARBON MATRIX WHICH IS IMPERVIOUS TO GASES. Blum, Pierre; Bochirol, Louis; Moreau, Claude. (to Commissariat a l'Energie Atomique). British Patent 1,050,233. Dec. 7, 1966. Priority date Oct. 17, 1963 and Aug. 14, 1964, France.

A process for the fabrication of articles formed by the dispersion of a refractory material within a carbonaceous matrix impervious to gases is particularly applicable to the fabrication of reactor fuel elements. The powdered refractory material having a particle size of <400 mμ is mixed with a binding agent that is chemically compatible with the refractory material. The binding agent is dispersed in a suitable solvent prior to being added to the refractory material. The paste is shaped into the suitable article, the water or other solvent is removed, and the matrix is formed by maintaining the article in a gaseous hydrocarbon atmosphere at a temperature within the range from 800 to 1000°C. The refractory material may be oxides of an actinide, a lanthanide, Be, Zr, Al, or Mg and the bonding agent is chosen from polysaccharides, gums, mucilages, starches, and alginated dispersed in water. If the refractory material is a carbide or nitride of an actinide or lanthanide, the binding agent consists of a drying oil or of ethylcellulose diluted in a volatile solvent. (B.L.M.)

13253 IMPROVEMENTS IN OR RELATING TO GRAPHITE ARTICLES. Roberts, Fred (to United Kingdom Atomic Energy Authority). British Patent 1,053,645. Jan. 4, 1967. Filed July 17, 1963.

A process for the production of graphite artifacts comprises mixing a powder of graphite and/or graphitizable carbon with dibenzanthrene (violanthrine) or dibenzathrone (violanthrone), pressing to form a shaped green body, heating to a carbonizing temperature in the absence of air, and then heating to a temperature in excess of the carbonizing temperature. The process is suitable for the production of fuel for a nuclear reactor by mixing carbonaceous nuclear fuel particles with the graphite and the dibenzanthrene or dibenzanthrone prior to pressing. The pressing step may be carried out either hot or cold, but if the hot pressing temperature is sufficiently high (750 to 800°C) to cause carbonization, further baking or carbonizing steps may be unnecessary. (B.L.M.)

13254 PROCESS AND APPARATUS FOR THE PRODUCTION OF MONOCRYSTALS OF NUCLEAR MATERIALS. Beucherie, P.; Wurm, J. G. (to EURATOM). Canadian Patent 747,288. Nov. 29, 1966. Priority date June 15, 1962, Germany.

Monocrystals of UC were prepared in a vacuum below 10^{-6} mm Hg by electrothermic vaporization in a chamber formed within the UC body and subsequent sublimation of vapor on portions of the chamber wall which were kept at a lower temperature. The vaporizing energy was supplied inductively at high frequency to the walls of the body with the exception of the sublimation surfaces. A field concentrator was interposed between the body and the inductive winding. A temperature of about 2200°C was required in the vaporing zone. (auth)

Properties Evaluations

Refer also to abstracts 13123, 13148, 13234, 13239, and 13243.

13255 (GA–7069) STATUS OF DEVELOPMENT OF DISPERSED FUEL PARTICLES IN A BERYLLIUM OXIDE MATRIX. Meyer, R. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 1966. Contract AT(04-3)-187. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The future of BeO and its usefulness in nuclear reactor systems is considered. It was concluded that BeO should be used as a moderator or a fuel matrix. The latter appears to be an alternate type of fuel to coated particles where it is operated in the range of 1000°C or higher. Under these conditions, it is relatively inert to atmospheric contamination. Additionally, BeO has a high specific power and a good packing fraction of fuel. It is shown to be capable of withstanding an environment as high as 1600°C. Tests are described and results presented. (M.C.G.)

13256 (LA-DC-8022) ANOMOLOUS SUPERCONDUCTING PROPERTIES OF REFRACTORY CARBIDES AND NITRIDES OF GROUP IVa AND Va ELEMENTS. Giorgi, A. L.; Szklarz, E. G.; Wallace, T. C. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 19p. (CONF-661207-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From British Ceramic Society Meeting, London, England.

The variation of the superconducting transition temperature (T_c) of the fcc (NaCl-type) form of NbC, TaC, HfN, and (Hf,Zr)N solid solution was studied as a function of the composition over the homogeneity range of the various compounds. In all cases T_c was found to vary sharply with stoichiometry. For NbC and TaC, changes in T_c ranged from a condition of no superconducting transition for measurements down to 1.05°K for the lowest C content, to T_c values of 9.7°K for $TaC_{.987}$ and 11.1°K for $NbC_{.977}$. An opposite behavior was observed in the HfN system. The highest T_c, 8.7°K, was obtained for the lower stoichiometry and no superconducting transition was found above 2.0°K for the composition $HfN_{1.12}$. The transition temperature for the (Hf,Zr)N solid solution series increased smoothly as the composition became richer in Zr and reached its maximum value of 10.7°K for $ZrN_{.948}$. When T_c was plotted as a function of the lattice parameter, the resulting curves were similar for all materials studied. T_c increased smoothly with increasing lattice parameter. (auth)

13257 (N–66-21018) DEVELOPMENT OF OXIDATION-RESISTANT COATINGS FOR USE ABOVE 3500 DEG F. Campbell, P. F.; Gebler, K. A.; Ortner, M. H. (Vitro Labs., West Orange, N. J.). Sept. 1965. Contract NAS9-3413. 83p. (NASA-CR–65285). CFSTI $3.00 cy, $0.65 mn.

The physical properties of a number of oxidation resistant coating materials for protecting Ta-base alloys at temperatures above 3500°F are reviewed and summarized in a table. Also tabulated is information on the sources of supply from which the materials were obtained, and the results of chemical analysis of the powders. Investigated were coating rates; particle size effects; the sintering of pure oxides; pure intermetallics; and composite pellets. Metallic binders for ZrB_2 and $MoSi_2$ coatings were also studied. WSi_2 was investigated as a base coating material, and sintering studies of refractory oxides are also reported. Photomicrographs of several sintered oxides are presented along with a photograph of a high temperature oxidation test furnace, and a schematic diagram of an experimental induction-heated vertical ZrO_2 muffle furnace. (STAR)

13258 (N–66-26662) DISPERSION STRENGTHENING OF METALS. Progress Report, September 1965–February 1966. Grant, Nicholas J.; Ewell, Gary; Hunkeler, Francis; Schilling, William; Dalal, Harish; (and others) (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). 1966. 17p. (NASA-CR–75136). CFSTI $3.00 cy, $0.65 mn.

Apparatus for controlled oxidation of Fe–Be alloy powders was constructed, and the procedural details are presented. Weight-change values and preliminary metallographic observations indi-

cated that significant amounts of BeO formed only in those internally oxidized samples exposed for 24 to 30 hours at 850 and 1000°C. The microstructures of the bulk samples showed progressive inward penetration of a precipitate zone with increased time and temperature of treatment. Research on the mechanism of deformation and fracture in oxide-dispersion-strengthened alloys is also discussed. Vacuum-melted Cu–Al alloys were converted into finely machined chips and ball-milled into near micron powders. Another group of the alloys were homogenized and then cold rolled. Other research areas mentioned are: oxide-dispersion-strengthened alloys by surface and internal oxidation processes; internal oxidation processes; and control of chromium oxide content in oxidation-resistant, oxide-dispersion-strengthened alloys. (STAR)

13259 (N-66-34696) EFFECTS OF HYDROSTATIC PRESSURE ON THE MECHANICAL BEHAVIOR OF BODY CENTERED CUBIC REFRACTORY METALS AND ALLOYS. Interim Technical Report No. 4, June 1, 1965–June 1, 1966. Radcliffe, S. V.; Das, G.; Trester, P. (Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy). June 1966. 45p. (NASA-CR-77383). CFSTI $3.00 cy, $0.65 mn.

The influence of the volume proportion of second-phase particles on the decrease in flow stress for a series of annealed iron–carbon alloys after subjection to a hydrostatic pressure of 20 kilobars established that the maximum change occurs for alloys containing 1 to 2 vol % for the particular morphology used. The existence of an increase in the minimum or critical pressure for the development of pressure-induced changes in yield behavior with increase in volume of second phase is indicated. Measurements of tensile ductile–brittle transition behavior for fully recrystallized commercial purity tungsten and tungsten–1 wt % thoria alloy after subjection to a hydrostatic pressure of 20 kilobars show no change in transition temperature, within the accuracy of measurement, from that of the as-recrystallized materials. (auth)

13260 (ORNL-3970, pp 36-41) PHYSICAL PROPERTIES. McElroy, D. L. (Oak Ridge National Lab., Tenn.).

The thermal conductivity of single and polycrystalline Si was measured from 91 to 1280°K. The thermal resistivity is linear with temperature below 1050°K, but the slope changes near the Debye temperature (650°K). Above 1050°K, an electronic contribution was observed and agreed in magnitude with values calculable from the electrical resistivity. Analysis of the tungsten results led to a Lorenz number greater than the classical limit of 2.443×10^{-8} $(V/°C)^2$; this value can be qualitatively explained by inclusion of a nonnegligible third term in the Lorenz-number series expansion. This third term is proportional to the cubic temperature dependency of the electrical resistivity. Based on the behavior of neighboring lanthanides and metallic melts and existing theories, the thermal conductivity of Pm was estimated to 2000°C. Work to broaden the temperature limits of physical-property measurement capacity and measurements on Cr, W, Fe, Al, Pt, and Mo were initiated. Thermal-conductivity measurements below 140°C were completed on Al_2O_3, MgO, Y_2O_3, ThO_2, ThO_2–UO_2, SAP, W–Ta, and W–Re alloys, Hastelloy X, and Inconel 626. A hot-cell thermal-conductivity apparatus is being constructed for testing of irradiated specimens. (auth)

13261 (ORNL-TM-1692) CHARACTERIZATION OF U_3O_8 DISPERSIONS IN ALUMINUM. Hobson, D. O.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Characterization of dispersion fuels is essential for establishing material and process specifications and can help predict irradiation performance. The highly fragmented and stringered nature of oxides in fabricated Al-base dispersions required the development of an improved technique to quantitatively evaluate dispersions containing nonspherical dispersoids. In place of using the point or line methods developed for spherical oxides, a fragmentation ratio was measured by counting the small fragments generated from the original particles during fabrication. This technique was successfully demonstrated by evaluating the propensity of three different commercial grades of U_3O_8 powder to fragment and stringer during plate fabrication. The resistance of the oxide to fragmentation and stringering varied with oxide density, particle sphericity, surface area, and particle spacing. Generally, the fragmentation ratio decreased with increasing particle density and sphericity. Fuel inhomogeneity also induced particle fragmentation. Stringering increased with increasing oxide surface area but depended strongly on processing and the ability of the oxide to resist fragmentation. (auth)

13262 (PWA-2979) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Semiannual Progress Report, May 15, 1966–November 14, 1966. Luoma, W. L. (Pratt and Whitney Aircraft, East Hartford, Conn.). Dec. 20, 1966. Contract NAS3-4174. 25p. (NASA-CR-72149).

The testing of two AISI-310 stainless-steel tubes coated with $FeTiO_3$ and $CaTiO_3$ was continued at 1350°F. Total test times accumulated were 19,245 hours for the $CaTiO_3$-coated specimen and 18,330 hours for the $FeTiO_3$-coated specimen. The emittance of both specimens continues to remain steady at 0.88. Some separation of the $FeTiO_3$ coating occurred during the past 4000 hours at the ends of the specimen and around the black-body holes. Two 5000-hour thermal cycling tests were started for Nb–1% Zr tubes coated with $FeTiO_3$. One specimen is being cycled between 1500 and 1800°F, and the second between 1500 and 1900°F. The first specimen has accrued 2100 hours of testing and 1310 thermal cycles. The second has accrued 1440 hours of testing and 900 thermal cycles. Both specimens have stable emittances between 0.88 and 0.90, and no changes in the appearances of the specimens have occurred. (auth)

13263 MAGNETIC PROPERTIES OF EuO AT LOW TEMPERATURES. Samokhvalov, A. A.; Bamburov, V. G.; Volkenshtein, N. V.; Zotov, T. D.; Ivakin, A. A.; Morozov, Yu. N.; Simonova, M. I. (Inst. of Metal Physics, Sverdlovsk, USSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 1951-4(Feb. 1967). Translated from Fiz. Tverd. Tela, 8: 2450-4(Aug. 1966).

Magnetization curves are reported for the ferromagnetic oxide EuO at 4.2, 20.4, and 82°K. The temperature dependence of the spontaneous magnetization is measured from 1.7°K and above. The temperature dependence of the spontaneous magnetization is discussed on the basis of spin-wave theory. The exchange integral I is worked out from the results obtained for the low-temperature region; the value obtained for I is equal to 0.394k. It is shown that the applicability range of the Bloch law is extended by incorporating a correction term varying in proportion to $T^{\frac{5}{2}}$ although the coefficient of proportionality C_1 associated with $T^{\frac{5}{2}}$, which is empirically determined to give the best agreement with the experimentally observed spontaneous magnetization curve, is very different from the value predicted by theory. (auth)

13264 IONIC CONDUCTIVITY IN BeO. Cline, Carl F.; Carlberg, John; Newkirk, Herbert W. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Amer. Ceram. Soc., 50: 55-6(Jan. 21, 1967). (UCRL-70046).

Measurements on the ionic conductivity of high-purity BeO were made at eight points from 1187 to 1684°C. Results obtained were in the 100% range. (J.G.B.)

13265 DIFFUSION OF CARBON IN TANTALUM. Son, Pongun; Ihara, Seiichi; Miyake, Masanobu; Sano, Tadao (Osaka Univ.). Nippon Kinzoku Gakkaishi, 30: 1137-40(1966). (In Japanese).

The diffusion coefficients of C in Ta was studied by tracer techniques using ^{14}C over the temperature range from 1450 to 2200°C. The diffusion coefficients are described by the equation, $D = 0.012 \exp(-40.3/RT)$ cm^2/sec. Comparing these results with the values obtained by the internal friction method at about 350°C, it can be understood that the activation energy for carbon diffusion in Ta takes constant values of 39 to 40 kcal/mol over a wide temperature range of 300 to 2200°C and further that the diffusion of C in Ta is operated by an interstitial mechanism even at a temperature as high as 2200°C. (auth)

13266 THERMAL DISSOCIATION OF LITHIUM, RUBIDIUM, AND CESIUM METANIOBATES. Pinaeva-Strelina, M. M.; Dmitriev, I. A. (Ural Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1248-53(July 1966). (In Russian).

The vacuum thermal dissociation of $LiNbO_3$, $RbNbO_3$, and $CsNbO_3$ was studied, and an attempt was made to elucidate the mechanism by which admixtures of metallic Ta influence the course of the process. The metaniobates were heated at a pressure of the order of 10^{-4} mm Hg up to 1200°C with and without addition of Ta. The accelerating effect of Ta on the vacuum thermal dissociation was demonstrated, and a correlation was observed between the dissociation rate and the amount of metallic Ta. The NbO_2 phase was found in the involatile decomposition product; the volatile product contains the free alkali metal. The presence of a correlation between the dissociation rate and the amount of Ta after a considerable degree of decomposition has been reached leads to the hypothesis that Ta exerts a direct influence on the volatile products of the system, possibly by accelerating some gas-transport process. (ATD)

13267 VISCOSITY OF MOLTEN B_2O_3. Eppler, R. A. (Glidden Co., Baltimore). J. Amer. Ceram. Soc., 49: 679-80(Dec. 1966).

An attempt was made to remove H_2O from molten B_2O_3 before viscosity measurements by the choice of starting materials and by prolonged high-temperature bakeout before measurement. Vis-

cosity was measured by the concentric cylinder method. The data are presented in a table and graph for temperatures from 640 to 1279°C. They can be fit with fair accuracy ($\Delta \log \eta < 0.06$) to the Fulcher equation: $\log \eta = 0.198 + (1451.303/T - 169.7°C)$. (M.C.G.)

13268 ROLE OF IRON IN THE OXIDATION OF MOLYBDENUM DISILICIDE. Ban, Zvonimir; Ogilvie, Robert E. (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 236: 1738-42(Dec. 1966).

Oxidation experiments were conducted above 600°C to investigate the oxidation products formed on the surface of $MoSi_2$. Results are presented, which indicate that minor Fe impurities play a key role in the oxidation behavior of $MoSi_2$ above 600°C. Based on considerations of the crystal chemistry of the oxidation products, $MoSi_2$ with Re and Fe additions was found to be resistant to oxidation in the pesting temperature range. (auth)

13269 PROPERTIES OF PYROLYTICALLY PRODUCED BORON FIBERS. Galasso, F.; Salkind, M.; Kuehl, D.; Patarini, V. (United Aircraft Research Labs., East Hartford, Conn.). Trans. Met. Soc. AIME, 236: 1748-51(Dec. 1966).

Properties of B fibers, produced by reacting BCl_3 and H_2 on W wire substrate, were investigated at different reacting temperatures. Three general types of B were identified by means of x-ray powder diffraction techniques: at low temperatures (below 1400°C) the B was deposited in the amorphous form; at temperatures between 1400 and 1500°C the B was deposited in the β tetragonal form; and above 1500°C the B was deposited in the β rhombohedral form. Mechanical measurements were made on amorphous B produced at 1300°C and the results tabulated. The larger-diameter fibers appeared to be consistently stronger than the smaller-diameter fibers. Young's modulus of the B fiber was measured and the values ranged from 55.8 to 64.3×10^6 psi. The effects of heat treatment in both Ar and air on the room-temperature tensile strength of B fibers were studied. Results indicated that in air the strength of the fibers decreased slowly with increasing heat-treating temperatures up to 500°C; above this annealing temperature the strength of the fibers decreased drastically. (D.H.M.)

13270 DIFFUSION IN CERAMIC MATERIALS. Lovell, A. L. Nottingham, Eng., Univ. of Nottingham, 1966. Thesis.

Self-diffusion rates for uranium and sulphur in US and for uranium and phosphorus in UP were measured. The method adopted consisted of allowing a radioactively labeled sample to diffuse into a cylindrical pellet of unlabeled material during a high-temperature isothermal anneal. The activity distribution profile was then determined by sectioning the pellet and radioassay of the removed layers. Diffusion coefficients and activation energies for diffusion were calculated. (106 references). (UK)

13271 THERMODYNAMICS OF CERTAIN REFRACTORY COMPOUNDS. VOLUME II. THERMODYNAMIC TABLES, BIBLIOGRAPHY, AND PROPERTY FILE. SECTIONS VII, VIII, AND IX. Schick, Harold L. (ed.). New York, Academic Press, 1966. 791p.

A compilation in tabular form of the thermodynamic properties of the borides, carbides, nitrides, and oxides of 31 elements in the temperature range of 0 to 6000°K is presented. The values for the following thermodynamic functions are tabulated: heat capacity, entropy, free energy function based on 298.15°K, heat content, free energy of formation from the elements in their standard states, heat of formation, and log K_p. A bibliography and a property file, which is essentially a subject index for use with the bibliography, are also included. (B.L.M.)

Structure and Phase Studies

Refer also to abstracts 12379, 13190, and 13243.

13272 (N-66-37678) FEASIBILITY STUDY OF SECONDARY EMISSION ELECTRON MICROSCOPY FOR EXAMINING MATERIALS CONTAINING DISPERSED OXIDE PARTICLES. Norris, L. Fredrick; Cremens, Walter S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1966. 51p. (NASA-TN-D-3650). CFSTI $3.00 cy, $0.65 mn.

The feasibility of using a secondary-emission electron microscope (SEEM) to examine dispersion-strengthened materials was explored. Ni, W, and Al containing submicron oxide dispersoids were examined and the results compared with micrographs from a conventional electron microscope. A high metal/oxide contrast, desirable for quantitative metallography, was observed in most of the materials examined, but an unexpected preferential enlargement of oxide particle images was discovered, which precluded anticipated use of the SEEM for measurement of microstructural parameters. Various levels of image brightness were also observed in a composite foil laminate of several metals. Phase discrimination between metals and between oxides was found to be limited to those combinations having substantially different yields of secondary electrons. (STAR)

13273 (LA-tr-66-84) STUDY OF Ho_2C BY NEUTRON DIFFRACTION. Bacchella, G. L.; Meriel, P.; Pinot, M.; Lallement, R. Translated by Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.), from Bull. Soc. Franc. Mineral. Crist., 89: 226-8(1966). 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The rhombohedral structure of ordered Ho_2C was defined by neutron diffraction. It can be considered as a stratification, normally at the three-fold axis of a succession of layers of Ho-C-Ho-□ .... The ordered magnetic structure is complex. (auth)

13274 THE SYSTEM Sc_2O_3–B_2O_3. Levin, Ernest M. (National Bureau of Standards, Washington, D. C.). J. Amer. Ceram. Soc., 50: 53-4(Jan. 21, 1967).

Phase equilibrium relations of the $Sc_2O_3 - B_2O_3$ system were studied by the quenching technique. The phase diagram is characterized by a single binary compound, $ScBO_3$, which melts congruently at 1610 ± 10°C, and by a large region of liquid immiscibility extending at 1526 ± 5°C from almost pure B_2O_3 to 34.0 mole % Sc_2O_3. X-ray diffraction data are tabulated. (J.G.B.)

13275 HIGH-TEMPERATURE PHASE-EQUILIBRIA IN THE Th–U–C SYSTEM IN THE PRESENCE OF FREE CARBON. Henney, J.; Jones, J. W. S. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc., 65: 613-26 (Nov. 1966). (AERE-R-5093).

The Th–U–C system was studied in the presence of about 1 wt % free C. Using several techniques including thermal analysis and high-temperature x-ray diffraction it was shown that extensive solid solutions are formed between ThC_2 and UC_2. At 1050°C ThC_2 can dissolve up to 57 wt % UC_2, and UC_2 can dissolve up to 30 wt % ThC_2. At temperatures above 1820°C UC_2 changes from a tetragonal to a cubic structure, and at temperatures higher than about 1490°C ThC_2 changes from a monoclinic to a cubic structure via a tetragonal phase, which exists from 1410 to 1490°C. In the region where ThC_2 and UC_2 are cubic there is complete solid solubility. The phase boundary separating the cubic solid solution from the lower temperature forms extends from 1820°C for UC_2, through a minimum at 1150°C and a composition 40 wt % ThC_2 · 60 wt % UC_2, to 1490°C for ThC_2. At temperatures below about 1700°C the $(U,Th)C_2$ solid solution does not extend to the U–C boundary because of the formation of U_2C_3, and at 1500°C U_2C_3 is in equilibrium with a $(U,Th)C_2$ solid solution containing 3 to 4 wt % ThC_2. (auth)

13276 PHASE EQUILIBRIA IN THE SYSTEM CaO–Yb_2O_3. Barry, Thomas L.; Stubican, V. S.; Roy, Rustum (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc., 49: 667-70(Dec. 1966).

Phase equilibrium relations in the system CaO–Yb_2O_3 were studied. Results of this work demonstrated the existence of four crystalline phases: $Yb_2O_3 \cdot 3CaO$, $Yb_2O_3 \cdot 2CaO$, $Yb_2O_3 \cdot CaO$, and $2Yb_2O_3 \cdot CaO$. The $2Yb_2O_3 \cdot CaO$ phase was metastable at all temperatures and was obtained only by rapid quenching from the melt. The crystalline solubility limit of Yb_2O_3 in CaO at 1850°C was slightly greater than 8 mole %, whereas no solubility of CaO in Yb_2O_3 was detected. All four compounds had subsolidus minimums of stability and dissociated into the component oxides below 1800°C. Data are also presented for the systems CaO–Gd_2O_3 and CaO–La_2O_3. (auth)

13277 DIFFUSION OF CARBON IN TANTALUM MONOCARBIDE. Resnick, R. (General Telephone and Electronics Labs., Bayside, N. Y.); Seigle, L. Trans. Met. Soc. AIME, 236: 1732-8(Dec. 1966).

The inert-marker movement experiment indicated that the ratio of the intrinsic diffusion coefficients $D_C : D_{Ta} \cong 80 : 1$ in TaC at 2500°C. Measurements of the diffusion coefficient of C in nonstoichiometric TaC at temperatures from 1700 to 2700°C revealed that D_C increased with decreasing C content, but much less than expected from the probable change in vacancy concentration with C content. A diffusion process involving two simultaneously operating mechanisms is postulated, and shown to be theoretically feasible. The average value of the carbon diffusion coefficient is given by $D_C = 0.18 \exp[(-85{,}000 \pm 3000)/RT]$ sq cm per sec over the composition range 46 to 49.5 at. % C. (auth)

13278 STUDY OF BINARY OXIDES OF URANIUM AND RARE EARTH ELEMENTS IN THE REGION RICH IN RARE EARTH OXIDES. Koshcheev, G. G.; Kovba, L. M. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1254-60 (July 1966). (In Russian).

The interaction of rare earth oxides R_2O_3 (R = La, Sm, Dy, Yb) with UO_3 and the solubility of the latter in the rare earth oxides were studied by x-ray phase analysis. In $R_2O_3 : UO_3$ systems with

R_2O_3 > 50 mole %, the existence of three phases was established: a cubic solid solution with a fluorite structure, and UR_4O_{12} and R_2O_3-type compounds. In La and Sm in the range $UO_2 : R_2O_3$ = 1 : 1.25 – 1 : 1.75, another phase was found which like UR_4O_{12} has a rhombohedral lattice. The binary oxides UR_4O_{12} have the structure of Tb_7O_{12}. The indexing of x-ray patterns of the oxides UR_4O_{12} is tabulated. In the $La_2O_3 - U_3O_8$ system, another rhombohedral phase was observed up to 1100°C; its composition is $2La_2O_3 \cdot U_3O_8$ with sublattice parameters (in the hexagonal derivation) a = 10.21 + 0.01 Å, c = 9.668 ± 0.002 Å. (ATD)

13279 REACTION OF URANIUM OXIDES WITH VANADIUM. Efremova, O. A.; Kovba, L. M. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 169: 1123-5(1966). (In Russian).

A phase diagram was constructed for the $U_3O_8 - UO_2 - V_2O_3 - V_2O_5$ system at 900°C. In the system $UO_2 - U_3O_8$ at 900°C UO_{2+x}($x \leq 0.195$), U_4O_9, U_3O_{13+x}, and U_3O_{8-z} phases were found; the presence of V_2O_3, V_2O_5, V_nO_{2n-1} (n = 4 to 8), VO_2, $V_{12}O_{26}$, and V_2O_3 oxides was observed in the $V_2O_3 - V_2O_5$ system, and previously in the system U – V – O, UV_2O_8, $U_2V_6O_{21}$, UVO_5, UV_3O_{10}, and UV_2O_5 were found. Roentgenographic studies were made of various ratios of oxide mixtures annealed in a vacuum for 120 hr at 900°C. The results were tabulated and analyzed. (R.V.J.)

13280 TUNGSTEN BORIDES IN BORON FIBERS. Galasso, F. (United Aircraft Corp., East Hartford, Conn.); Paton, A. Trans. Met. Soc. AIME, 236: 1751-2(Dec, 1966).

The x-ray-powder-diffraction pattern of WB_4 was compared to those obtained for the tungsten borides in B fibers, produced by reacting BCl_3 and H_2 on hot W wire. The lines of the powder pattern of WB_4 were present in the B fiber powder pattern in addition to the lines of δ WB, W_2B_5, and the halos of amorphous B. Attempts to index the data for tungsten boride in B fibers on the tetragonal unit cell were not as satisfactory as indexing the data on a hexagonal cell. Further experimental evidence for the hexagonal indexing of the WB_4 phase was obtained from precession photographs of a fragment of the tungsten boride obtained by melting B on a W substrate. (D.H.M.)

13281 PHASE DIAGRAM OF THE Gd_2O_3–Cr_2O_3 SYSTEM. Shevchenko, A. V.; Lopato, L. M.; Tresvyatskii, S. G. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1240-3(July 1966). (In Russian).

X-ray, microstructural, and chemical analyses as well as infrared spectroscopy were used to study the phase relationships in the $Gd_2O_3 - Cr_2O_3$ system in the 1600 – 2400°C range. It is shown that the system contains only one congruently melting chemical compound, $GdCrO_3$, which has a melting point of 2350 ± 30°C. The compound forms eutectics; the eutectic with Gd_2O_3 is composed of 77 mole % Gd_2O_3 and 23 mole % Cr_2O_3 and melts at 2060 ± 20°C; the eutectic with Cr_2O_3 is composed of 15 mole % Gd_2O_3 and 85 mole % Cr_2O_3 and melts at 2120 ± 30°C. Some physicochemical properties of gadolinium chromite (density, coefficient of linear thermal expansion, crystal optical properties) were determined. (ATD)

13282 STUDY OF THE PHASE DIAGRAM OF THE Y_2O_3–Cr_2O_3 SYSTEM. Pavlikov, V. N.; Lopato, L. M.; Tresvyatskii, S. G. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1244-7(July 1966). (In Russian).

The phase diagram of the $Y_2O_3 - Cr_2O_3$ system was studied in the 1800 – 2500°C range. The diagram was plotted on the basis of petrographic and x-ray structural studies of samples subjected to heat treatment in argon. It was found that the system contains only one compound of composition 1 : 1, melting congruently at 2310 ± 30°C. The compound undergoes a partial thermal dissociation in the solid phase, which causes the maximum on the fusibility curve to be diffuse. The compound forms two eutectics: one with Y_2O_3, composed of 72 mole % Y_2O_3 and 28 mole % Cr_2O_3 and melting at 2020 ± 30°C, and one with Cr_2O_3, composed of 80 mole % Cr_2O_3 and 20 mole % Y_2O_3, melting at 2070 ± 30°C. No solid solutions were observed in the system. (ATD)

Radiation Effects

Refer also to abstracts 12735, 13213, 13647, and 14109.

13283 (CONF-661003-17) STOICHIOMETRY EFFECTS IN MOLTEN CENTER, OXIDE FUELS. OXYGEN REDISTRIBUTION AND THERMAL CONDUCTIVITY EFFECTS. Christensen, J. A.; de Halas, D. R.; Horn, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

Temperature distributions in 100% dense UO_{2+x} fuels during molten center irradiation were determined as functions of composition for $-0.10 \leq x \leq 0.15$. Radial oxygen redistribution was measured in $UO_{2.00}$, $UO_{2.02}$, $UO_{2.05}$, and $UO_{2.15}$ by remotely performed coulometric analyses of samples removed with diamond core drills. The heat rating required to initiate center melting decreased continuously with O : U between 1.90 and 2.15. The variation was adequately defined for design purposes by a linear function. The decrease in heat rating required for fuel melting as oxygen content increased reflected principally the decrease in melting point as O : U increased above 2.00. Migration of oxygen to the molten center occurred for O : U's > 2.00, presumably because of higher oxygen solubility in the melt in equilibrium with the solid. Central compositions of $UO_{2.43}$, $UO_{2.18}$, and $UO_{2.09}$ were measured in fuels with pre-irradiation uniform compositions of $UO_{2.15}$, $UO_{2.05}$, and $UO_{2.02}$, respectively. Slight oxygen movement both to the center and to the cooler fuel regions was observed in $UO_{2.00}$. The microstructure of UO_{2-x} specimens showed displacement of uranium metal precipitates from the columnar grains to the molten center. In general, center melting appeared to reduce the effects of departures from stoichiometry on fuel properties since the excess component segregates to the melt. (P.C.H.)

13284 (GEMP-452) THERMAL DIFFUSIVITY MEASUREMENTS ON PRE- AND POST-IRRADIATED BeO. Freeman, R. J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Nov. 15, 1966. Contract AT(40-1)-2847. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurement of thermal diffusivity in the temperature range from 300 to 1000°C on Armco Iron, pre-irradiated BeO, and post-irradiated BeO having acquired irradiation dosage to 2.5×10^{21} fluence (nvt) where $E_n \geq 1$ MeV is presented. A laboratory developed laser was employed as a source of transient energy which was absorbed on the front surface of a small, thermally insulated specimen. The rear-surface temperature history was detected by an infrared sensor and displayed on an oscilloscope, and photographed by a Polaroid Land camera. Thermal diffusivity was determined from the temperature versus time trace using precision techniques. Measurements on Armco Iron were compared with data reported in the literature. Estimated precision is of the order of 2 percent. The effect of thermal anneal and microcracking on the thermal diffusivity of the irradiated material is shown. Derived thermal conductivity from thermal diffusivity measurements on BeO in comparison with reported values is also presented. (auth)

13285 (EURAEC-1730) A STUDY ON THE RELEASE OF FISSION GASES FROM UO_2 SAMPLES IRRADIATED TO VARIED DOSES. Quarterly Report No. 3, April–June 1966. Baffigo, V.; Gerevini, T.; Rossi, A. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Aug. 1966. Contract 043-65-TEEI(RD). 8p. (EUR-3301). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Samples of sintered UO_2 were irradiated to doses from a few MWd/t to ~8000 MWd/t. Fused UO_2 samples from 4 different sources were irradiated to doses from a few MWd/t to ~2000 MWd/t. Data are presented in tables. It was concluded that the thermal diffusion of fission gases during irradiation is quite negligible. (M.C.G.)

13286 (EURAEC-1772) A STUDY ON THE RELEASE OF FISSION GASES FROM UO_2 SAMPLES IRRADIATED TO VARIED DOSES. Quarterly Report No. 4, July–September 1966. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Contract 043-65TEEI(RD). 19p. (EUR-3319). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Experiments were made on the effects of radiation at various doses on UO_2 at 1400°C. Measurements were also made of the UO_2 surface area by the BET method. Detailed calculations were made of the burnup obtainable following irradiation of samples in the Sorin RS-1 swimming pool reactor. Data are tabulated. (P.C.H.)

13287 (N-66-33436) RADIATION EFFECTS ON SILICON. Quarterly Progress Report No. 6, April 1–June 30, 1966. Horiye, H.; Naber, J. A.; Wikner, E. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 11, 1966. Contract NAS7-289. 15p. (NASA-CR-77053). CFSTI $3.00 cy, $0.65 mn.

Investigations were made of the damage and annealing properties of high-purity n-type silicon after irradiation at 4.2°K with 25-MeV electrons. Additional experiments were performed to verify some of the results and conclusions drawn last period on the annealing characteristics of the E center. (STAR)

13288 (NUMEC-3432-27) IRRADIATION TESTING OF PuO_2–UO_2 FUELS. Quarterly Progress Report, July 1–September 30, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Dec. 1966. Contract AT(30-1)-3432. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A post-irradiation examination was made of a 20 wt % PuO_2–UO_2 capsule irradiated to 20,000 MWd/t. Data on fuel fabrication method, pin numbers, and position of the fuel elements in the irradiation capsule are tabulated. The capsules were disassembled and the fuel elements removed, cleaned, photographed, dimensioned, gamma scanned, punctured for fission gas, and sectioned for metallographic examination. The results showed that the percent fuel grain growth is consistent with the amount of fission gas release. (P.C.H.)

13289 (ORNL-P-2355) CLADDING AND DISPERSION FUEL DEVELOPMENT AT ORNL. Cunningham, J. E.; Ullmann, J. W. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 23p. (CONF-660336-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Fast Flux Test Facility Driver Fuels Meeting, Richland, Wash.

The technology of the UO_2–stainless steel dispersion fuel is reviewed with special attention given to irradiation experience accumulated over the past 15 years. Shortcomings of this fuel type for application in FFTF are discussed. (P.C.H.)

13290 (SC-DC-66-2433) TRANSIENT RADIATION DEFECTS. Stein, Herman J.; Vook, Frederick L. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 29p. (CONF-670303-2). DTIE.

From Symposium on Radiation Effects in Semiconductor Components, Toulouse, France.

Transient-defect studies in neutron-irradiated Si resolved two annealing stages near room temperature. The experimental activation energy of ~0.3 eV inferred for the longer half-life defects was very similar to those reported for neutral vacancy and interstitial annealing in Si. For neutron irradiations it is concluded that the shorter half-life defects represent intrinsic defect interaction within clustered defect regions, and that the longer half-life process represents intrinsic defect motion either away from or into the clustered defect regions. Both annealing stages in silicon transistors exhibited a dependence on carrier injection into the base region, which is thought to reflect charge-state-dependent defect recombination and motion. (auth)

13291 EFFECTS OF NEUTRON RADIATION ON ELECTRICAL RESISTANCE OF TITANIUM AND CHROMIUM CARBIDES. Kovalchenko, M. S.; Ogorodnikov, V. V. At. Energ. (USSR), 21: 302-4(Oct. 1966). (In Russian).

Neutron radiation effects on TiC and Cr_7C_3 were studied using 8 mm and 10 to 15 mm specimens of TiC and Cr_7C_3 compressed for 5 min at 120 kg/cm^2 at 600 to 800°C. The results showed that irradiation with 10^{18} and 10^{2} n/cm^2/sec doses increased the electrical resistance of Cr_7C_3 35 and 60%, respectively. For the same doses electrical resistance of TiC increased 19 and 23%, and for 10^{16} n/cm^2/sec dose it increased 17%. The temperature coefficient of electrical resistance for the examined specimens was 1.05×10^{-3} and 0.82×10^{-3} grad^{-1}, respectively. (R.V.J.)

13292 USE OF IRRADIATED POLYETHYLENE FOR TELEPHONE CABLE AND RADIO FREQUENCY COAXIAL CABLE. Miyamori, S.; Ishikawa, K.; Uda, Y. Sumitomo Denki, 94: 80-8(Dec. 1966). (In Japanese).

There are some cases in which heat resistance becomes necessary for polyethylene insulated telephone and rf coaxial cables. In case of wiping or soldering cable conductors for instance, the cable insulation should not be allowed to melt or deform, because it has to retain excellent electrical properties. In this case, it is very useful to use irradiated polyethylene, which does not melt or deform at high temperatures, to the cable insulation instead of conventional polyethylene. The use of irradiated polyethylene for the insulation of telephone and rf coaxial cables is discussed. (auth)

13293 STRENGTH AND FRACTURE OF GRAPHITE. Taylor, R. (United Kingdom Atomic Energy Authority, Risley, Eng.); Kelly, B. T.; Gilchrist, K. E.; Morris, F. W.; Hodds, A. C. pp 236 of Proceedings of Conference on Physical Basis of Yield and Fracture. Stickland, A. C. (ed.). London, Institute of Physics and Physical Society, 1966.

Compression tests were carried out under hydrostatic pressures up to 560 kg/mm^2 on unirradiated graphite and on graphite irradiated to 11.5×10^{20} n/cm^2 at 150°C. Crack propagation studies under slow tensile strain rates were also made. It was considered from fracture observations that the large pores in graphite are the sources of stress concentration and the points from which cracks are propagated. It is possible that at high doses cracks under compression are not closed; at low doses and in unirradiated graphite fracture occurs by the propagation of closed cracks. It is postulated that a number of cracks running from large pores will cease to propagate by running out of initial orientation and that ultimate failure occurs by shear of thin layers between cracks. (UK)

13294 IN-PILE MEASUREMENT OF STRUCTURAL AND STOICHIOMETRIC EFFECTS ON UO_2 THERMAL CONDUCTIVITY. Balfour, M. G.; Ferrari, H. M. (Westinghouse Electric Corp., Pittsburgh). 22p. (CONF-661003-12). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

An in-pile study of the effects of columnar grain growth and hypostoichiometry on UO_2 thermal conductivity was performed to provide mechanistic information on the behavior. UO_2 fuel capsules instrumented with refractory thermocouples were irradiated at specific power levels of 22 to 25 kW/ft. Successful direct temperature measurements were obtained in-pile up to 2250°C. The change in the temperature differential across the columnar grain region was measured continuously as these grains formed. Columnar grain formation had no significant effect on UO_2 thermal conductivity between 1700 and 2150°C, contrary to a postulated enhancement of thermal conductivity by radiant transmission. Capsules containing $UO_{2.005}$ and $UO_{1.941}$, respectively, were irradiated under similar conditions to determine comparatively the heat-transfer effects of hypostoichiometric fuel. Results show that the average thermal conductivity of $UO_{1.941}$ during irradiation is nearly 20% higher than $UO_{2.005}$ between 600 and 2250°C. This result is consistent with a theoretically predicted enhancement of UO_2 thermal conductivity by a high-temperature electronic contribution to heat transfer. (auth)

13295 METHOD OF TESTING GRAPHITE. Brocklehurst, James Ernest (to United Kingdom Atomic Energy Authority). U. S. Patent 3,285,072. Nov. 15, 1966. Priority date July 26, 1962, Great Britain.

A method of testing polycrystalline graphite for its dimension-determining properties under irradiation with neutrons comprises exposing a sample of the graphite to Br vapor so that the Br is absorbed progressively into the sample. Measurements are made on the sample to determine bulk dimensional changes as a function of the amount of Br absorbed; and from such measurements, a deduction is made as to the extent to which changes due to irradiation are reflected in the bulk changes. (B.L.M.)

Plastics and Other Materials

Refer also to abstracts 12484–12486, 12735, 13645, and 13646.

13296 (CEA-R-3061) ETUDE DE L'IRRADIATION AUX NEUTRONS RAPIDES DU SILICIUM AU MOYEN DE JONCTIONS PIN. (Silicon P.I.N. Junctions Used for Studies of Radiation Damage). Lanore, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1966. 107p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

Irradiation of silicon p-i-n junction was studied primarily for the purpose of developing a radiation damage dosimeter, but also for the purpose of investigating silicon itself. The rate of recombination of electrons and holes is a linear function of defects introduced by neutron irradiation. Two methods were used to measure that rate of recombination: forward characteristic measurements and recovery time measurements. In order to explain how these two parameters depend on recombination rate a theory of the p-i-n junction was developed. Carrier lifetime dependence versus temperature is also considered. Annealing effects in the range from 70 to 700°K were studied and it was found that five annealing stages with corresponding activation energies exist. As an application for these studies, a radiation damage dosimeter was developed with which several experiments in facilities such as Naïade or Marius were carried out. (auth)

13297 (JEN-178-DF/I-54) EFECTO DE LA DEFORMACION PLASTICA SOBRE LA CINETICA DE CENTROS DE COLOR F Y M EN NaCl IRRADIADO CON RAYOS γ. (Effect of Plastic Straining on the F and M Centers Kinetics in γ-Irradiated NaCl). Agullo Lopez, Fernando (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1966. 114p. (In Spanish). Dep. mn.

The effect of plastic straining on the room-temperature F and M growth curves in a γ-radiation field was analyzed. Crystals were strained after F-saturation was reached and then irradiation was continued. The new F growth curve consists of an initial fast

growing stage due to additional vacancies created by deformation being turned into F center, followed by a linear stage. Its slope is higher than that prior to straining. Also the role of straining on M center thermal decay, as well as on the F → M reaction under F light, was investigated. This reaction was shown to preferentially occur where intense gliding has developed. (auth)

13298 (N-66-19036) EFFECTS OF SHUNT CAPACITANCE ON TRANSIENT EFFECTS CAUSED BY ELECTRON IRRADIATION OF A POLYETHYLENE TEREPHTHALATE INSULATED RIBBON WIRE. Miller, William E.; Phillips, Donald H. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Mar. 1966. 17p. (NASA-TN-D-3321). CFSTI $3.00 cy, $0.65 mn.

An investigation of the effects of external "shunt" capacitance upon the electron radioinduced voltage pulses from a 20.3-centimeter strip of polyethylene terephthalate insulated ribbon wire irradiated with 60 keV electrons is reported. Both the average and the maximum pulse heights observed varied inversely with the total capacitance in the system. A change in load resistance caused a negligible variation in average and maximum pulse heights. After irradiation, electron discharge patterns known as Lichtenberg figures were found in the polyethylene terephthalate insulation. Rough calculations indicate that the power density along the discharge path is adequate to produce the observed physical damage. (auth)

13299 (ORNL-TM-1757) THE EFFECT OF AIR ON THE RADIATION-INDUCED DEGRADATION OF POLYTETRAFLUOROETHYLENE (TEFLON). Parkinson, W. W.; Kirkland, W. K. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The tensile properties of polytetrafluoroethylene (Teflon) specimens of $1/32$- and $1/16$-inch thickness were measured before and after gamma irradiation in air and in vacuum. The effect of air was to reduce by about an order of magnitude the dose required for a given fractional decrease in original properties. There was little effect of thickness over the range studied. In both air and vacuum, the tensile strength decreased rapidly to 40 to 45% of its original value and then remained relatively constant with increasing dose, up to 10^7 RADS in the case of air. The elongation-at-break showed a maximum at 10^4 RADS followed by a sharp decline to 0.1 in./in. at 10^6 RADS for air irradiations. (auth)

13300 HEAVY SHIELDING CONCRETES. Dubois, F. Bull. Inform. Sci. Tech. (Paris), No. 109, 49-73(Nov. 1966). (In French).

The principal concretes used for biological shielding are discussed. Following a brief outline of the conditions required in materials used for shielding against nuclear radiations, the following are examined: the properties of the components of concrete used for building biological shielding; determination of the compositions of concretes for shielding against different radiations; and the physical and mechanical properties of the most important heavy and special concretes normally used in the nuclear industry. Results are given in tabular form, together with a bibliography dealing with the most recent work on these materials. (auth)

13301 PHYSICO-CHEMICAL PROPERTIES OF SHIELDING CONCRETES. Bernard, A. Bull. Inform. Sci. Tech. (Paris), No. 109, 39-48(Nov. 1966). (In French).

Shielding concretes only differ from ordinary structural concretes by a higher density or a greater proportion of "special elements" added to slow down and capture neutrons. Boron and H_2 are often used for neutron shielding. The most convenient way of increasing the H_2 content of concretes is to raise the content of chemically bound water; this is a function of the mineralogical nature of the components, the hydraulic binding agent and the stability of the aggregates chosen. Boron is added to concretes in the form of natural borates of the type xB_2O_3, $yCaO$, nH_2O. The problems of incompatibility which arise with the binding agents are examined. Under the conditions of use peculiar to nuclear applications, the radiation attenuation properties are impaired by carbonation phenomena which lead to a reduction in the water content of lime-containing materials. (auth)

13302 SHIELDING STUDIES AND CONCRETES. Condat, M.; Lafore, P.; Lott, M.; Rastoin, J. Bull. Inform. Sci. Tech. (Paris), No. 109, 21-38(Nov. 1966). (In French).

A review of the process of radiation attenuation by materials is presented followed by a survey of the qualities and defects of conventional concretes, showing how they can be improved from the shielding view point by: the introduction of heavy elements; addition of light elements; addition of substances containing hydrogen or water of constitution; and by the introduction of absorbent materials (containing B, Li, or rare earths). The process by which water is released in heated concretes is discussed. A brief description is given of the main solutions considered or already adopted for the construction of shielding concretes (particularly refractory and absorbent concretes). Attenuation experiments and measurements performed on concretes containing serpentine and rare earths and a heavy concrete containing hydrogen and boron (iron + colemanite) for loading/unloading machines are described. (auth)

13303 TEMPORARY NEUTRON DAMAGE IN TRANSISTORS. Barnett, B.; Langsam, L. M.; Rosen, S. L.; Schoch, C. B.; Schow, D. A. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). 29p. (CONF-661122-1). DTIE.

From 5th Annual Symposium on Failure in Electronics, Columbus, Ohio.

The amount and the duration of temporary neutron damage were measured in a wide variety of types of transistors at the White Sands Pulsed Reactor. They all showed a decrease in the large-signal common-emitter current gain lasting about 1 sec. Half of the damage recovered in a time of 0.0002 to 0.05 sec for different types, and the ratio of the peak damage (just after the burst) to the permanent damage varied from 1.5 to 3. The amount and the duration of the effect were much smaller in samples operated at relatively high junction temperatures. A model is proposed to explain the effect on the basis of the kinetics of the trapping and recombination processes occurring. (auth)

13304 IMPROVEMENTS IN CARBON ARTICLES. Bickerdike, Robert Lewis; Hughes, Garyth (to United Kingdom Atomic Energy Authority). British Patent 1,054,117. Jan. 4, 1967. Filed Nov. 6, 1962.

A process is described for the preparation of a carbonaceous artifact with dispersed inclusions, particularly for the preparation of reactor fuel elements in which the nuclear fuel constitutes the dispersed inclusions. The included material is mixed with carbon particles of a smaller size; the mixture is compacted in such a way as not to hazard the integrity of the inclusions but to cause the carbon particles to occupy the interstices between the inclusions; and a carbon binder is then deposited on the inclusions and on the carbon particles by the decomposition of a carbonaceous material. A fuel element manufactured by the process may be rendered impermeable as a whole by laying down an impermeable carbon skin over the external surface of the element. Petroleum coke is a suitable carbonaceous binding material to bond the dispersed material to the carbon particles. (B.L.M.)

PHYSICS (GENERAL)

Astrophysics

13305 (N-66-24986) FORMATION OF SOLAR PROMINENCES. Raju, P. K. (Yale Univ., New Haven, Conn.). [1966]. 93p. (NASA-CR-74804). CFSTI $3.00 cy, $0.65 mn.

A nonlinear treatment of prominence condensation from the corona by means of thermal instability is presented. It is found that the prominence stage is reached after times of the order of 10^6 seconds. The major limitations on the process are due to magnetic fields; if the initial field strength is below 10^{-4} gauss, heat conduction by free electrons prevents the formation of condensations. On the other hand, fields above 10^{-1} gauss prohibit a significant density increase. It is suggested that the observed density values develop from secondary processes, after the temperature has reached prominence values as a result of initial thermal instability. (auth)

13306 INFLUENCE OF THE IONIZED MEDIUM ON SYNCHROTRON EMISSION SPECTRA IN THE SOLAR CORONA. Ramaty, R.; Lingenfelter, R. E. (Univ. of California, Los Angeles). J. Geophys. Res., 72: 879-83(Feb. 1, 1967).

Suppression of synchrotron emission at low frequencies owing to the influence of the ionized coronal plasma is proposed to account for the observed low frequency cutoff in type-IV radio bursts. Since in a plasma the index of refraction is frequency dependent and less than unity, the phase velocity of electromagnetic waves is greater than c at low frequencies with the result that synchrotron emission is suppressed. A calculation is made of the synchrotron emission resulting from high-energy electrons radiating in the coronal plasma, and these spectra exhibit sharp low-frequency cutoffs similar to those observed in type-IV meter and decimeter radio bursts. (auth)

13307 OBSERVED PARTICLE EFFECTS OF AN INTERPLANETARY SHOCK WAVE ON JULY 8, 1966. Van Allen, James A. (Univ. of Iowa, Iowa City); Ness, Norman F. Contract NAS5-9076. J. Geophys. Res., 72: 935-42(Feb. 1, 1967).

At 2106 UT on July 8, 1966, a distinctive, discontinuous drop in the intensities of solar protons $E_p \sim 0.5$ MeV was observed by Explorer 33 in interplanetary space at 187,000 km in the antisolar direction from the earth. The protons had been emitted by the sun in a flare whose onset time was 0027 UT on July 7. The intensity drop is attributed to the effects of an interplanetary shock wave whose detailed structure was observed by a triaxial flux gate magnetometer on the same satellite. (auth)

13308 STELLAR EVOLUTION. VII. EVOLUTION OF STARS OF 5 AND 9 SOLAR MASSES. Hofmeister, Emmi (Columbia Univ., New York). Z. Astrophys., 65: 164-84(1967). (In German).

New evolutionary tracks were calculated with the computer program described previously. Some modifications have been built in, e.g., improved formulas for helium burning and new opacities including line absorption. Evolutionary tracks are given for stars with 5 and 9 solar masses and different chemical compositions, namely a mixture with 4.4% heavy elements corresponding to extreme population I and a mixture with 2.1% heavy elements corresponding to median population I. All tracks were computed from the main sequence up to the phase of helium shell burning. The results for the stars with the extreme population-I mixture are very similar to the results given in papers II, III, and IV of this series. For five solar masses also the influence of the mixing length in the nonadiabatic outer layers is discussed. The tracks for median population I have only very short loops in the HR diagram and therefore it is seen that the lengths of the loops depend critically on the chemical composition. The purpose of these calculations was to obtain new data for some studies of Cepheids. (auth)

13309 STRUCTURE OF A PLANE IONIZATION FRONT. Singh, S. N. (Univ. of Kentucky, Lexington); Nigam, L. N. Z. Astrophys., 65: 114-22(1967).

A one-dimensional, steady ionization front, considered to be a shock front, was studied taking into account viscosity and heat conduction. The problem was reduced to three first-order ordinary differential equations involving two dimensionless parameters—the Mach number M_0 and B. It is shown that ionization fronts for Mach number 1 occur, which would be forbidden in the combustion wave theory by the Chapman–Jouguet hypothesis. The numerical solutions of the equations keeping $M_0 = 1$ fixed and varying the values of B are sought by the computer CDC 3600. B at normal temperature and pressure is of the order of 0.005. It is found that with $B = 0.5777$ and $M_0 = 1$ smooth integral curves occur, which form the transition from ionized HII to unionized HI regions. It is concluded therefore that diffusive effects are important for the study of ionization fronts. It is found from the linearized equations that a characteristic speed for the propagation of a disturbance, in addition to the sound velocity, will be given by $Q = MJ_0/\rho_0$ as suggested by Kahn. (auth)

13310 MIGRATION OF MAGNETIC FIELDS ON THE SUN. Tuominen, Jaakko (Univ. of Helsinki). Z. Astrophys., 65: 111-13(1967).

The theory developed by Leighton for the transport of magnetic fields on the sun does not explain the observed average latitudinal drift (i.e., proper motion) of sunspots, while for the latitudinal drift of magnetic regions, even in the maximum case, it gives a barely observable value. (auth)

13311 COLOR-BRIGHTNESS DIAGRAM AND DISTANCE OF THE OPEN STAR CLUSTER NGC 6694 = M 26. Grubissich, Claudio (Univ., Basel). Z. Astrophys., 65: 105-10(1967). (In German).

A combination of all available photographic and photoelectric observations in addition to new photographic observations with the 48″ Palomar Schmidt leads to a distance of 1550 psc. (auth)

13312 SEARCH FOR NEBULOSITY IN THE HIGH GALACTIC LATITUDE RADIO SPURS. Meaburn, J. (The Univ., Manchester, Eng.). Contract AF 61(052)-694. Z. Astrophys., 65: 93-104(1967).

A search for nebulosity in the high galactic latitude radio spurs is described. Positive results were obtained in the vicinity of the Cetus Arc where a 25° long arc of filamentary nebulosity was found to follow part of the outer edge of this radio feature. This nebulosity is shown to resemble that of the Cygnus Loop in structure and in position relative to the radio ridge. This seems to indicate that the nebulosity is associated with the Cetus Arc and that these optical and radio features are the remnants of the same nearby supernova explosion. (auth)

13313 GRAVITY DARKENING FOR STARS WITH CONVECTIVE ENVELOPES. Lucy, J. B. (Columbia Univ., New York). Z. Astrophys., 65: 89-92(1967).

A modified form of von Zeipel's gravity-darkening law appropriate for stars with convective envelopes is obtained. The modified law is $T_e \propto g^\beta$ with $\beta = 0.08$ in place of von Zeipel's value of $\beta = 0.25$. The importance of this result for the theory of the light curves of W Ursae Majoris stars is emphasized. (auth)

13314 VARIATIONAL PRINCIPLE FOR THE EQUILIBRIUM OF A RELATIVISTIC, ROTATING STAR. Hartle, James B. (Princeton Univ., N. J.); Sharp, David H. Contracts AT(11-1)-68; AF 49(638)-1545. Astrophys. J., 147: 317-33(Jan. 1967). (CALT-68-83).

A variational principle which supplies a general approach to the study of the equilibrium configurations of relativistic, rotating stars is formulated and proved. It is also shown that the relativistic variational principle passes over directly, in the nonrelativistic limit, into the well-known Newtonian variational principle for rotating fluids. Some applications are discussed in the concluding section. (auth)

13315 POST-NEWTONIAN EFFECTS OF GENERAL RELATIVITY ON THE EQUILIBRIUM OF UNIFORMLY ROTATING BODIES. II. THE DEFORMED FIGURES OF THE MACLAURIN SPHEROIDS. Chandrasekhar, S. (Univ. of Chicago). Astrophys. J., 147: 334-52(Jan. 1967).

The equations of post-Newtonian hydrodynamics are solved appropriately for a uniformly rotating homogeneous mass with symmetry about the axis of rotation. The post-Newtonian figure is obtained as a deformation of the Newtonian Maclaurin spheroid (with semi-axes a_1 and a_3, say) by a Langrangian displacement proportional to

$$\xi^{(2)} = \frac{1}{a_1^7}\,(\varpi^2 x_1, \varpi^2 x_2, -4\varpi^2 z),$$

where ϖ denotes the distance from the axis of rotation and x_1 and x_2 are the Cartesian coordinates in the equatorial plane. It is shown that the equation defining the boundary of the post-Newtonian configuration is of the form

$$\frac{\varpi^2}{a_1^2} + \frac{z^2}{a_3^2} - 1 - 2S_2\dagger(e)\,\frac{R_{SC}}{a_1}\left(\frac{\varpi^4}{a_1^4} - \frac{4\varpi^2 z^2}{a_1^2 a_3^2}\right) = 0,$$

where $S_2\dagger(e)$ is a determinate function of the eccentricity e of the Maclaurin spheroid and $R_{Sc}(= 2GM/c^2)$ is the Schwarzschild radius. The function $S_2\dagger(e)$ is tabulated. Further, the angular velocity of rotation of the post-Newtonian configuration differs from that of the Maclaurin spheroid by an amount which is also tabulated. The solution of the post-Newtonian equations exhibits a singularity at a certain eccentricity $e^*(= 0.985226)$ of the Maclaurin spheroid. The origin of this singularity is that at e^* the Maclaurin spheroid allows an infinitesimal neutral deformation by a displacement proportional to $\xi^{(2)}$; and the Newtonian instability of the Maclaurin spheroid at e^* is excited by the post-Newtonian effects of general relativity. (auth)

13316 DETECTION OF HEAVY ELEMENTS IN INTERGALACTIC SPACE. Rees, M. J.; Sciama, D. W. (Cambridge Univ., Eng.). Astrophys. J., 147: 353-6(Jan. 1967).

The discovery of several objects with red-shifts $\gtrsim 2$, in whose spectra the Lyman-α hydrogen line is visible, has made possible an extremely sensitive test for the presence of neutral hydrogen in intergalactic space. Even a density of 10^{-11} atm cm^{-3} would produce detectable absorption on the short wavelength side of the Lyman-α line in the spectrum of a distant source. It has been pointed out that some other ions might produce similar absorption edges. The possibility is discussed that such absorption may reveal the presence of heavy elements in intergalactic space, and that, conversely, the absence of absorption might enable one to place significant upper limits on the abundance of some elements in the gas. (W.D.M.)

13317 POSSIBILITY OF DETECTING QUARKS THROUGH ASTRONOMICAL OBSERVATIONS. Kuo, T. K.; Shen, C. S. (Purdue Univ., Lafayette, Ind.). Astrophys. J., 147: 356-9 (Jan. 1967).

Recent developments in elementary-particle physics have shown the SU(3) is at least an approximate symmetry group for strongly interacting particles. One of the unsolved questions is whether quarks, the three-dimensional representation of SU(3), do or do not exist. Whereas the success of SU(3) does not necessarily imply the existence of quarks, it is nonetheless difficult to understand their total absence. The possibility of detecting quarks through astrophysical observations is examined. A number of microwave and optical lines of the quark ion together with their transition probabilities. The possibility of detecting the microwave lines depends on their peak optical depth. (W.D.M.)

13318 RADIATIVE CORRECTIONS TO THE NEUTRINO–ELECTRON INTERACTIONS. Hebb, J. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Astrophys. J., 147: 359-62(Jan. 1967). (CALT-68-80).

Radiative corrections to pair annihilation in stars and to neutrino-electron scattering experiments are considered. These corrections are expected to be of order $\alpha = 1/137$ smaller than the processes with no photon involved. When calculated in detail, the amplitudes to order α depend on the charge radius of the neutrino, which can only be estimated, since the field-theory calculations diverge. But with reasonable estimates, it is found that the corrections indeed produce an effect of only a few per cent on the stellar neutrino luminosities in the temperature range of interest and on the cross section measured in the scattering experiments. (W.D.M.)

13319 LONGITUDE DISTRIBUTION OF PROTON FLARES AS A FUNCTION OF RECURRENCE PERIOD. Wilcox, John M.; Schatten, Kenneth H. (Univ. of Calif., Berkeley). Contract Nonr-3656(26). Astrophys. J., 147: 364-7(Jan. 1967).

A recent paper by Warwick (1965) has pointed out that solar active regions associated with emission of protons show a striking grouping in heliographic longitude. An attempt is made to extend the analysis by Warwick by introducing the recurrence period as a parameter of the analysis. (W.D.M.)

13320 VIRIAL RELATIONS FOR UNIFORMLY ROTATING FLUID MASSES IN GENERAL RELATIVITY. Chandrasekhar, S. (Univ. of Chicago). Contract Nonr-2121(24). Astrophys. J., 147: 383-4(Jan. 1967).

In a recent paper Boyer (1966) has reduced the equation governing the hydrostatic equilibrium of a uniformly rotating fluid mass in general relativity to a form which allows of immediate integration in the case the specific entropy is a constant throughout. Boyer's form of the equation of hydrostatic equilibrium (in the more general case when the specific entropy is not necessarily a constant) leads directly to a class of moment relations (virial theorems) which can be used as checks, or as constraints, in the solution of the equations of hydrostatic equilibrium by a variational procedure. (W.D.M.)

13321 ABSORPTION SPECTRUM OF 3C 191. Burbidge, E. M.; Lynds, C. R. (Univ. of California, San Diego). Astrophys. J., 147: 388-90(Jan. 1967).

Bahcall (1966) has drawn attention to a correlation between the redshift of the narrow absorption lines in 3C191, measured by Burbidge, Lynds, and Burbidge (1966) (BLB) and Stockton and Lynds (1966) (SL), and the ionization potential of the ion having one more electron than the absorbing ion. Two points made by Bahcall were as follows: (1) He stated that a plot was made using the data of SL but could not be meaningfully interpreted since the four Si II lines detected showed a dispersion, $\Delta Z = 6.5 \times 10^{-3}$, which is as large as the total spread. (2) He suggested that the correlation is much improved if the line measured by BLB and SL at $\lambda = 3652$ Å is identified with the Mg II doublet at $\lambda_0 = 1239.9, 1240.4$ Å instead of with the N V doublet at $\lambda_0 = 1238.8, 1242.8$ Å, as taken by both BLB and SL. Issue is taken with Bahcall on both these points and it is concluded that from the data one cannot tell whether there is acceleration or deceleration, or whether the ions of highest potential are nearest or farthest from the energy source. (W.D.M.)

13322 BALLOON OBSERVATION OF THE X-RAY SOURCES IN THE CYGNUS REGION IN THE ENERGY RANGE 20 TO 130 keV. Bleeker, J. A. M.; Burger, J. J.; Deerenberg, A. J. M.; Scheepmaker, A.; Swanenburg, B. N.; Tanaka, Y. (Royal Dutch Academy of Sciences, Leiden). Astrophys. J., 147: 391-4(Jan. 1967).

Balloon observations were made of the x-ray sources in the Cygnus region in the energy range 20 to 130 keV. The x-ray counter consisted of a NaI(Tl) crystal; 75 mm in diameter by 5 mm thick. The crystal-photomultiplier assembly was mounted in a cylindrical tin cup (2-mm thickness), which provided an effective shield against background x rays. The balloon was launched from De Bilt, the Netherlands, on April 5, 1966, and reached a ceiling altitude of 5 gm/cm^3 residual atmosphere at 6:45 A.M. local time. The results presented were derived from data obtained between 7:10 and 7:50 A.M. (W.D.M.)

13323 INFRARED RADIATION FROM THE SEYFERT GALAXY NGC 1068. Pacholczyk, A. G.; Wisniewski, W. Z. (Univ. of Arizona, Tucson). Astrophys. J., 147: 394-6(Jan. 1967).

The nuclei of Seyfert galaxies and quasars show several similar features, like broad emission lines in their spectra, compact dimensions, and variable radio radiation. To the list of features common to some of those two types of objects is now added one more, namely, strong infrared radiation. Strong infrared radiation of the Seyfert galaxy 1068 was detected in Oct. 1966, when multicolor observations of this galaxy were made with the Johnson UBVRIJHKL photometers attached to the 60-inch telescope of the Univ. of Ariz. Observations were made with a 15-inch diaphragm. The photometric data obtained for NGC 1068 are listed and the colors of NGC 1068 together with those of a mean spiral galaxy and of 3C273 are given. (W.D.M.)

13324 QUASI-STELLAR SOURCE WITH A RAPIDLY EXPANDING ENVELOPE. Lynds, C. R. (Univ. of California, San Diego). Astrophys. J., 147: 396-9(Jan. 1967).

The spectrum of PHL 5200 appears to be more interesting than that of any other source studied thus far. Four spectrograms of this object have been obtained: three at low dispersion (8-Å resolution) and one at higher dispersion (4-Å resolution). One low dispersion and the high dispersion spectrograms are shown. An attempt is made to interpret the spectrum and it is suggested that the simplest model consists of a source of continuum radiation surrounded by a relatively quiescent region that is responsible for the emission lines. The emitting region is surrounded by an expanding envelope in which the absorption bands originate. (W.D.M.)

13325 X-RAYS FROM THE COMA CLUSTER OF GALAXIES. Friedman, H.; Byram, E. T. (Naval Research Lab., Washington, D. C.). Astrophys. J., 147: 399-401(Jan. 1967).

In a rocket flight on Nov. 25, 1964, Bowyer, Byram, Chubb, and Friedman surveyed the region of the north galactic pole in the 1- to 10-Å wavelength range and scanned through the Coma cluster of galaxies. The record of that flight was re-examined and no 1 to 10-Å flux from the Coma cluster could be detected. The rocket observations are described and the upper limit on the 1 to 10-Å flux are compared with extrapolations of the 25-keV flux. (W.D.M.)

13326 SCANNER OBSERVATIONS OF FOUR QUASI-STELLAR RADIO SOURCES. Wampler, E. Joseph (Univ. of California, Mount Hamilton). Astrophys. J., 147: 1-12(Jan. 1967).

Narrow-band observations of the continuum of four quasi-stellar sources are given. In general the continuum can be well fitted by a straight line in a ν, log f_ν plot. The lack of a detectable Balmer discontinuity in the three objects (3C 345, 3C 380, and MSH 14–12) that were observed to the red of the Balmer limit presents a serious difficulty in attempts to explain the continuum by means of the radiation from an optically thin hydrogen gas. Observations

of 3C 345 indicate a slight change of color with changes in brightness. There is some indication that the red wing of the Mg II line is variable. (auth)

13327 CORRELATIONS BETWEEN THE COLORS AND REDSHIFTS OF THE QUASI-STELLAR OBJECTS. Strittmatter, P. A.; Burbidge, G. R. (Univ. of California, San Diego, La Jolla). Astrophys. J., 147: 13-23(Jan. 1967).

The observed correlation between the colors and redshifts of the quasi-stellar objects is examined and shown to be due mainly to the presence of emission lines. The correlation is, however, of little use in predicting redshifts from photometric data. It is suggested that the rest-frame slope and level of the optical continuum are correlated with observed redshifts, becoming somewhat flatter and higher (relative to the lines and possibly also absolutely) with increasing z. The probable effect of blueshifts on the colors of quasi-stellar objects is discussed. (auth)

13328 DISTRIBUTIONS OF 10.6-CENTIMETER WAVELENGTH LINEARLY POLARIZED RADIATION OVER EIGHT EXTRAGALACTIC RADIO SOURCES. Seielstad, G. A. (California Inst. of Tech., Owens Valley). Astrophys. J., 147: 24-60 (Jan. 1967).

The distributions of the 10.6-cm wavelength linearly polarized radiation from the radio sources 3C 33, 3C 98, Pictor A, 3C 270, Centaurus A (central component), Hercules A, 3C 353, and 3C 452 were determined by fitting models to the measured Fourier transforms of the Stokes parameters I, Q, and U. With the exception of Hercules A each component of these double radio galaxies is significantly polarized, although the degree of polarization and the position angle of the plane of polarization angle is not necessarily the same. Furthermore, the polarization angle is not necessarily constant throughout an individual component. In every case the polarized regions are smaller than the total regions. It is suggested that the individual components of a double source are independent of one another and are not controlled by the parent galaxy. The degree of uniformity of the magnetic field within a component is independent of its age. In some cases the magnetic field is nearly homogeneous over dimensions of the order of kiloparsecs or even tens of kiloparsecs. There is no obvious unique orientation of the magnetic field relative to the major axis. (auth)

13329 FUNDAMENTAL LIMITATION OF THE ACCURACY OF ANGULAR MEASUREMENTS IN OBSERVATIONAL COSMOLOGY. Gunn, James E. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., [Pasadena]). Astrophys. J., 147: 61-72(Jan. 1967).

The statistical error introduced by gravitational scattering along the light path in measurement of angles subtended by very distant objects is investigated. It is found that, for very small angles, there is a standard deviation proportional to the "true" angle for a fixed redshift and increasing approximately as the $\frac{3}{2}$ power of the redshift. The severity of the effect depends somewhat on the world model, the parameters chosen for the statistical distribution of galaxies, and the sampling procedures, but errors of the order of a few per cent are to be expected at $z = 1$. (auth)

13330 PERTURBATIONS OF A COSMOLOGICAL MODEL AND ANGULAR VARIATIONS OF THE MICROWAVE BACKGROUND. Sachs, R. K.; Wolfe, A. M. (Univ. of Texas, Austin). Astrophys. J., 147: 73-90(Jan. 1967).

General-relativistic, spatially homogeneous, and isotropic $k = 0$ cosmological models with either pressure zero or pressure one-third the energy density are considered. The equations for general linearized perturbations away from these models are explicitly integrated to obtain density fluctuations, rotational perturbations, and gravitational waves. The equations for light rays in the perturbed models are integrated. The models are used to estimate the anisotropy of the microwave radiation, assuming this radiation is cosmological. It is estimated that density fluctuations now of order 10 per cent with characteristic lengths now of order 1000 Mpc would cause anisotropies of order 1 per cent in the observed microwave temperature due to the gravitational redshift and other general-relativistic effects. The $p = 0$ models are compared in detail with corresponding Newtonian models. The perturbed Newtonian models do not contain gravitational waves, but the density perturbations and rotational perturbations are surprisingly similar. (auth)

13331 INFRARED STARS. Wing, Robert F.; Spinrad, Hyron; Kuhi, L. V. (Univ. of California, Berkeley). Astrophys. J., 147: 117-47(Jan. 1967).

As the number of extremely red stars found by means of infrared sky surveys rapidly becomes larger, it becomes increasingly important to determine the spectral characteristics and the nature of the variability of at least a few such stars. A detailed study was made of the Taurus object, the Cygnus object, and TX Cam. The results depend primarily upon the measurements of molecular band strengths and unblanketed energy distributions made with photoelectric spectrum scanners in the wavelength range 0.8–1.1 μ. For the Taurus object, 32 Å/mm coudé spectrograms centered at 1.08 μ and a low-dispersion blue spectrogram are available. UBV photometry has been obtained for the Taurus object and TX Cam. That the Taurus object is a Mira-type variable is indicated by its visual and infrared light-curves, the strength of its hydrogen emission lines of the Balmer and Paschen series, its irregular Balmer decrement, and the shortward displacement of its hydrogen line P_γ with respect to the absorption spectrum. It appears that a complete cycle has not yet been observed, and that the period is longer than 532^d. TX Cam was previously known to be a Mira variable, likewise with an exceptionally long period (557^d). In the case of the Cygnus object, on the other hand, no definite variation in magnitude, color, or molecular band strength was found. (auth)

13332 SPECTROPHOTOMETRY OF VZ CANCRI. Danziger, I. J.; Oke, J. B. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., [Pasadena]). Contract AF 49(638)-1323. Astrophys. J., 147: 151-7(Jan. 1967).

Spectrophotometric spectrum scans and high-dispersion spectra have been obtained around several cycles of the short-period variable star VZ Cancri. Line-blanketing corrections were applied to the scan data to give continuum fluxes from which luminosity, temperature, and gravity as a function of phase were determined. The minimum temperature attained by VZ Cnc is similar to the minimum temperature of cluster-type variables of longer period such as RR Lyr, SU Dra, and X Ari. The relative phases of light, temperature, velocity, and gravity appear to be similar to those observed in other cluster-type variables. The gravity combined with the $P\sqrt{(\rho/\rho_\odot)} = Q$ relationship demonstrates that VZ Cnc has a lower mass and probably a lower value of Q than RR Lyrae. A differential curve-of-growth analysis relative to α CMi shows VZ Cnc to be slightly metal-deficient but it has an overabundance of lithium relative to the sun of +1.4 in the logarithm. (auth)

13333 RESONANT RESPONSES OF THE SOLAR ATMOSPHERE TO THE GRAVITATIONAL-HYDRODYNAMIC WAVES. Uchida, Yutaka (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 147: 181-92(Jan. 1967).

The propagation of low-frequency gravitational-hydrodynamic waves in a temperature-stratified model of the solar photosphere–low-chromosphere region with its "supergranulational" structure is discussed. It is shown that this portion of the atmosphere displays a variety of responses for the gravitational-hydrodynamic waves (gravitational-acoustic and internal-gravity modes) of different wave parameters; phenomena, such as resonant trapping of waves and resonant transmission or tunneling of waves into the upper atmosphere, are expected to occur depending on the combination of frequency and horizontal wavenumber. An eigenvalue problem is solved for the trapping case, and it is shown that an internal-gravity wave with a rough horizontal scale (wavelength) of 2000 to 3000 km and a period of about 300 sec can be resonantly trapped in this portion of the atmosphere. An inclusive physical picture for the observed oscillatory motion, together with the larger supergranulational structure, is proposed in this connection. Also, the transmissivity of the waves from the photosphere–low chromosphere to the upper layers is computed for both the transmission and the tunneling cases in order to have a rough idea about the kinetic energy transport to the corona by these gravitational-hydrodynamic waves. The result suggests that, in contrast to the importance of the internal-gravity mode in the oscillatory motion, the main contribution to the kinetic energy transport to the corona comes from the gravitational-acoustic mode waves. (auth)

13334 APPARENT AREA AS A BASIS FOR SOLAR FLARE IMPORTANCE. Sawyer, Constance B. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Astrophys. J., 147: 193-200(Jan. 1967).

If flare importance, based primarily on area, is to be insensitive to the flare's position on the solar disk, a need to know how apparent area depends on position is present. Earlier studies show that the ratio of corrected to apparent area seems to differ between small and large flares. Calculations based on a simplified model show that this apparent dependence is not real, but is introduced by observational loss of small flares. A relation between corrected area and apparent area that depends on central distance alone provides an adequate description of extensive world-wide flare data. (auth)

13335 INTERPLANETARY GAS. XIII. GROSS PLASMA VELOCITIES FROM THE ORIENTATIONS OF IONIC COMET TAILS. Brandt, John C. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 147: 201-19(Jan. 1967).

Results are presented concerning the velocity of the solar-wind

plasma as deduced from the observations of Type I (ion) tails contained in the comet catalogue of Belton and Brandt. The analysis is in the spirit of the early work by Biermann, where the orientations are interpreted on the basis of dynamical aberration. The major conclusions are as follows: (i) The solar wind has a fairly sharp velocity minimum at 150 ± 50 km/sec; this agrees with the prediction of Axford, Dessler, and Gottlieb. (ii) The solar-wind velocity is correlated with geomagnetic activity in a manner which confirms the relationship found from the Mariner II data by Snyder, Neugebauer, and Rao and from the travel times for geomagnetic storms by Hirshberg. The comet tail, Mariner II, and storm data are consistent with the expressions $w = 330 + 9.0\ \Sigma K_p$ (km/sec) or $w = 316\ A_p^{0.20}$ (km/sec), where w is the solar-wind velocity, ΣK_p is the sum of K_p for the day in question, and A_p is the surface magnetic disturbance index. These statistical relations hold over nearly the entire range of the magnetic indices. (iii) These relations predict a mean plasma velocity of 500 km/sec with only a 50 km/sec spread in the means between years of solar maximum and solar minimum. (iv) Evidence is found for a mean tangential component of the solar-wind velocity near earth of ≈10 km/sec directed in the sense of the solar rotation; the value of the tangential velocity is apparently lower for quiet conditions and higher for disturbed conditions in the interplanetary medium. (v) The sample of Type I comet tails (both direct and retrograde) is not uniformly distributed in space and time, and care must be exercised in drawing conclusions from the sample presently available; such bias may (at least in part) account for the curious dependence of the solar-wind velocity on heliographic latitude found by Pflug, where the minimum velocity is found in the sunspot zone. It appears that the latitude dependence of the plasma velocity cannot be determined with the information presently available. (auth)

13336 COROTATION AND SOLAR WIND IN THE SOLAR CORONA AND INTERPLANETARY MEDIUM. Ferraro, V. C. A.; Bhatia, V. B. (Queen Mary Coll., London). Astrophys. J., 147: 220-9(Jan. 1967).

The motion of the ionized gases in the atmosphere and surrounding medium of a rotating magnetic star and the sun is discussed in greater detail than hitherto. It is shown that strict corotation of the atmosphere can only exist if there is no stellar or solar wind. When a stellar or solar wind exists and the wind velocity is considerably smaller than the local Alfvén velocity, corotation holds approximately, although the magnetic lines of force are bent slightly backward. When the wind velocity much exceeds the local Alfvén velocity, there is no corotation; the angular velocity of the atmosphere decreasing steadily outward. In this case the lines of force are bent backward into an Archimedean spiral in agreement with Parker's result. It is shown that where the atmosphere corotates with the parent star or sun it does so within a limited region of space whose dimensions are approximately determined. (auth)

13337 VISCOUS-TRANSONIC FLOW IN THE ACCRETION AND STELLAR-WIND PROBLEMS. Axford, W. I.; Newman, R. C. (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). Astrophys. J., 147: 230-4(Jan. 1967).

A closed-form solution is given which describes transonic flow in the idealized stellar-wind and spherical-accretion problems including the effects of viscosity and heat conduction. (auth)

13338 GENERAL-RELATIVISTIC FLUID SPHERES. III. A STATIC GASEOUS MODEL. Buchdahl, H. A. (Australian National Univ., Canberra). Astrophys. J., 147: 310-16(Jan. 1967).

It is not difficult to find static spherically symmetric distributions of matter which satisfy the general-relativistic field equations. The situation is, however, rather more difficult if (i) the sphere is to be "gaseous" (i.e., the density is to vanish at the boundary), and (ii) if one requires that the various field quantities, and more especially the equation of state of the medium constituting the sphere, be exhibited in simple, closed form. A model is presented in detail for which the equation of state is $\rho = (1 + k^*)\sqrt{p - k^*p}$, where ρ and p are the ratios of density and pressure to their central values, and k^* is a parameter which can be freely chosen in the range $0 \leq k^* \leq k'$, with $k' = 5/7$ or 1, depending on certain physical conditions imposed upon the sphere. (auth)

13339 VARIATION OF THE POSITIONAL ANGLE OF THE POLARIZATION PLANE OF RADIOSOURCES WITH TIME. Sholomitskii, G. B. (Stemberg State Astronomical Inst., Moscow). Nature, 213: 580(Feb. 11, 1967).

Expansion of the volume in which relativistic particles, magnetic fields, and ionised gases are contained must be accompanied by a decrease of the flux density of the synchrotron radio-emission and a change in its polarisation parameters. An expression is given (and discussed) for the rate of change of the positional angle under conditions where the radioemission in linearly polarised, and the plane of polarisation undergoes Faraday rotation ϕ_s within the source itself and ϕ_g in the interstellar medium, assuming rapid expansion of the source. Some data are given for Cassiopeia A and the Crab Nebula. Measurements for radio-variable quasars are of particular interest, leading to the possibility of establishing whether the linearly polarised radio-emission comes from the variable central nucleus of the quasar and, if so, drawing some conclusions about the mechanism involved in the generation of variable radio-emission. (UK)

13340 SPECTRUM OF 3C273. Hazard, C.; Gulkis, S.; Bray, A. D. (Arecibo Ionospheric Observatory, Puerto Rico). Nature, 212: 461-3(Oct. 29, 1966).

The results of two recent occultation observations on 3C 273 which were made using the 1000 ft steerable radio telescope at Arecibo, Puerto Rico, are described. The first occultation (Sept. 7, 1964) was observed at 41.7, 195, and 430 Mc and was visible only at immersion as the emersion occurred outside the restricted field of view of the telescope. For the second occultation in June 7, 1965, observations were made at 41.7, 213, and 430 Mc. (W.D.M.)

13341 X-RAY EMISSION FROM OLD NOVAE. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York). Nature, 212: 493-4(Oct. 29, 1966).

The strong x-ray source in Scorpius has been identified with a very blue stellar object which has many of the characteristics of an old nova. It has been previously suggested that the thin-source bremsstrahlung in x-ray sources like Scorpius may arise from the vibrations of a neutron star. It is pointed out that similar hot coronas can arise from the vibrations of old nova. (W.D.M.)

13342 HYDROMAGNETIC ENERGY-BALANCE EQUATIONS FOR THE SOLAR ATMOSPHERE. Starr, Victor P.; Gilman, Peter A. (Massachusetts Inst. of Tech., Cambridge). Pure Appl. Geophys., 64: 145-55(1966).

Following the pattern established in meteorology, a system of energy balance equations for the solar atmosphere is presented. Since both hydromagnetic and thermodynamic processes are considered, the system includes kinetic, potential, thermal and magnetic forms of energy. Ionization energy is indirectly included in the treatment. The spatial distribution of the energy forms and the processes transforming them are separated into zonal means and departures from such means in order to depict turbulent eddy effects. Where available, data concerning solar processes are used in order to appraise certain of the terms which arise. (auth)

13343 GRAVITATIONAL COLLAPSE OF A RADIATING STAR. Israel, W. (Dublin Inst. for Advanced Studies). Phys. Lett., 24A: 184-6(Jan. 30, 1967).

The analytic completion of Vaidya's radiating Schwarzschild metric is presented. It is applied to a description of the irreversible collapse to zero volume of a radiating star, and employed to illustrate the effects of nonstatic disturbances on the extended Schwarzschild manifold. (auth)

13344 PROCEEDINGS OF THE PLASMA SPACE SCIENCE SYMPOSIUM HELD AT WASHINGTON, D. C., JUNE 11–14, 1963. Chang, C. C.; Huang, S. S. (eds.). Astrophysics and Space Science Library. Volume 3. New York, Gordon and Breach Science Publishers, 1966. 385p. $19.50. (CONF-77).

Eighteen papers arranged according to related topics are presented. The topics cover the following subjects: solar phenomena; interplanetary plasma and cosmic rays; magnetosphere, magnetopause, and trapped radiation; and miscellaneous geophysical and lunar phenomena. In an appendix, two lectures, "NASA Space Science Program — Progress and Potential" and "The Keynote Speech," are included. (J.H.M.)

Atomic and Molecular Physics

Refer also to abstract 13600.

13345 (AD-639934) SUPERPOSITION OF CONFIGURATIONS AND NATURAL SPIN ORBITALS. APPLICATIONS TO THE He PROBLEM. Shull, Harrison; Loewdin, Per-Olov (Uppsala Univ. (Sweden)). June 15, 1958. Contract AF 61(514)-1200. 42p. (TN-13). CFSTI $3.00 cy, $0.65 mn.

The method of superposition of configurations is examined in its application to the helium atom in two cases: a 21 × 21 matrix including all configurations up to 6s2, and a 20 × 20 matrix with all configurations up to the 4-quantum level, including angular terms. An analysis of the results suggests that inner orbitals may be better represented by pure exponentials than by Hartree-Fock orbitals whenever additional correlational degrees of freedom are permitted. Expressed in approximate natural spin orbital from, the wave function is almost invariant to choice of basis

set, provided that the latter is reasonably chosen. In particular, the necessity of including continuum terms along with the discrete hydrogen-like set is demonstrated. (auth)

13346 (N-66-26698) ATOMIC PROCESSES IN PLASMAS. Wilkerson, T. D. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Oct. 1965. 34p. (NASA-CR-75078; BN-407). CFSTI $3.00 cy, $0.65 mn.

Experimental plasma physics deals both with atomic and collective processes, i.e., with two- and three-body interactions of particles and photons vs many-body interactions over distances of order a Debye length or cyclotron radius. Measurement of atomic radiation and collision coefficients which are important in stellar atmospheres, dilute plasmas in space, and high temperature plasmas on earth are studied. Radiative transition probabilities will be measured for spectral lines of several light elements; e.g., C1, C11, S1, S11, Ne1, Al, All, between 2000 and 12,000 Å. Other elements and shorter wavelengths will follow this initial program. The spectroscopic source is a gas-driven shock tube which operates up to 15,000°K with at least 100 microseconds of steady conditions behind the reflected shock. Particular attention has been paid to direct measurement of the gas properties, rather than relying on shock wave theory alone. Data are presented on excitation temperature measured by the line-reversal technique. The flash lamp and fiber optics employed for this and other purposes are also described. (auth)

13347 (N-66-39932) PREFACE TO THE NONADIABETIC THEORY OF ELECTRON-HYDROGEN IONIZATION. Temkin, A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 11, 1966. 28p. (NASA-TM-X-55573). CFSTI $3.00 cy, $0.65 mn.

The zeroth order problem is shown to give rise to an $E^{\frac{1}{2}}$ threshold law. The stationary phase result for the asymptotic form of the zeroth order problem is shown to lead to a complete suppression of S-wave ionization events in which the energies of the scattered and ejected electron are equal. Extending the stationary phase results to our conjectured asymptotic form for the complete S-wave problem leads to an even greater suppression in the neighborhood of equal energy events. The combination of such an S-wave cross section together with reasonable higher partial wave cross sections yields a qualitative understanding of experimental ionization energy loss measurements in helium. (auth)

13348 (ORNL-4063, pp 71-87) ATOMIC AND MOLECULAR CROSS SECTIONS. Barnett, C. F.; Hunt, W. E.; Krause, M. O.; Langley, R. A.; Nakai, M. Y.; Ray, J. A.; Russek, A.; Toburen, L. H. (Oak Ridge National Lab., Tenn.).

The problem of the existence of highly excited Rydberg states in H_2 molecules has been formulated rigorously, and computer solutions are being sought for autoionizing transition rates for such states. Predictions were made that the Rydberg states of HD, because of its dipole moment, would decay faster than those of H_2, which possesses only a quadrupole moment. This hypothesis has been confirmed by observing the population of states $n > 11$ for both HD and H_2. Analyses have been made of the statistics of secondary electron emission from heavy particles impinging on metal surfaces. Single particles striking a surface will produce groups of 0, 1, 2, . . . , n electrons with a certain probability P_n. These electrons are postaccelerated and counted by a high-resolution silicon barrier detector. The pulse spectrum yields the frequency of electrons in each n group. The probability distribution, P_n, has been found to be a characteristic Poisson distribution, $P_{(n)} = e^{-\gamma}\gamma^n/n!$. Application of this analysis to the measurement of low-energy neutral particles yields information which determines the absolute efficiency of particle detection. For a counting system of an AgMg surface and a silicon barrier detector, the detection efficiency was 77% for H^0 at 500 eV and rose monotonically to a plateau of 100% at an incident energy of 2 keV. Using these same techniques, the average secondary emission coefficient has been determined for H^+, H^0, and N^0 particles on Cu and AgMg in the energy range 500 eV to 50 keV. Measurements have also been made for the secondary emission coefficient for a copper single crystal, and values have been obtained for the reflection coefficient of H^0 and electrons from metal surfaces. Charge-transfer cross sections of hydrogen particles (H^+, H^0) have been made in H_2, He, Ar, N_2, O_2, CO, CO_2, H_2O, CH_4, and C_2H_6 target gases. The energy range was 100 to 2500 keV. Also, studies have been made of nonresonant charge transfer of one to five electrons for multiply charged rare-gas ions in their own gases. Differential cross sections of these processes are reported in the energy range 0.4 to 2.2 keV times the charge of the primary ion. (auth)

13349 (ORNL-4063, pp 88-93) HIGH-CURRENT BEAM PRODUCTION AND INJECTION. Davis, R. C.; Hall, R. R.; Kelley, G. G.; Morgan, O. B.; Stratton, R. F. (Oak Ridge National Lab., Tenn.).

A 20-keV beam of neutral hydrogen atoms has been produced by the dissociation and neutralization of a 40-keV H_3^+ beam by means of a magnesium vapor cell developed and built by the DCX-1 group. The four-electrode H_3^+ ion source and the recently developed 100-kV non-PIG accelerator column described previously were used to produce the beam. The H_3^+ beam was passed through the neutralizer and a system of apertures which simulate the DCX-3 and INTEREM geometries. Equivalent currents of 102 and 222 mA of 20-keV H^0 have been produced in these geometries respectively. Beam profile measurements have been made of both the 40-keV H_3^+ and the 20-keV H^0 beams. These measurements show that the current density is sharply peaked on axis when the beam is focused to produce maximum current, even through a relatively large aperture. The maximum current density measured was 121 mA/cm² for 40-keV H_3^+ and 163 mA/cm² for 20-keV H^0 at a distance of 117 cm from the magnetic lens. (auth)

13350 (SC-DC-1559) ELECTRON EMISSION FROM A (100) TUNGSTEN SURFACE UNDER PROTON BOMBARDMENT. Ewing, Ronald I. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 7p. (CONF-661208-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Nashville, Tenn.

The yield of electrons from a clean (100) surface of tungsten under bombardment by protons at normal incidence is reported as a function of proton energy in the range 50 to 225 keV. The maximum value of the yield is 1.51 ± 0.03 electrons per incident proton at a proton energy of 125 keV. The yield from the (100) plane surface fell $11 \pm 2\%$ below the yield from a polycrystalline surface. The tungsten surface was cleaned by flash heating a single crystal tungsten ribbon to 2400°K in a vacuum chamber in which the total pressure was about 2×10^{-10} torr. The yield was measured with the surface at room temperature, about two minutes after the surface was cleaned, while the time for a monolayer of residual gases to form on the surface was greater than two hours. (auth)

13351 (UCRL-16898, pp 82-6) FLUCTUATIONS OF ENERGY LOSS BY HEAVY CHARGED PARTICLES IN THIN ABSORBERS. Maccabee, Howard D.; Raju, Mudundi R.; Tobias, Cornelius A. (California Univ., Berkeley. Lawrence Radiation Lab.).

In a thin absorber (one in which the total energy lost is small compared to the kinetic energy of the particle), the probable number of large-energy-loss collisions may be so small that the random statistical fluctuations in this number result in significant fluctuations in the energy lost in this mode, and thus fluctuations in the total energy transfer will occur. This phenomenon was theoretically investigated by Landau, Symon, Vavilov, et al. In Vavilov's exact treatment, the dimensionless parameter κ is introduced, and it is shown that for $\kappa \ll 1$ the fluctuations are large, while for $\kappa \gg 1$, the fluctuations are negligible, and the normal gaussian shape of the total energy loss distribution is valid. The Vavilov theory was investigated experimentally over the whole range of κ, and its implications for biological targets were determined. Results are reported from a series of experiments using 730-MeV protons and 910-MeV α particles, covering the range of κ from 0.0033 to 1.02. Measurements were made using a Li-drifted Si semiconductor with a smaller detector used as a coincidence gate to eliminate all pulses from particles passing through the edge of the analyzing detector. (C.H.)

13352 (UCRL-16898, pp 87-96) SECONDARY-ELECTRON DISTRIBUTION FOR HEAVY IONS. Oda, Nobuo; Lyman, John T. (California Univ., Berkeley. Lawrence Radiation Lab.).

Two kinds of approaches to the δ-ray correction for heavy ions are discussed. These include the space-averaged picture and extended-track picture. The fundamental quantity for the space averaged picture is the differential flux (slowing-down spectrum) $\phi_\delta(E)$ of δ rays. Experimental results on the low-energy part of $\phi_\delta(E)$ are presented, that is, on the energy spectrum and the absolute yield values. Results showed that when the velocities of primary ions are the same, the yields for each kind of ion are proportional to the total LET's and that when the velocities are different, the yield for higher velocity is higher than that for lower velocity. The discussion of several related problems suggests the importance of studies on the behavior of energy spectra of secondary electron flux. (auth)

13353 (UCRL-17253) APPLICATION OF THE PDP-5 TO DATA HANDLING FOR MESON-PRODUCED X RAYS. Lafore, Robert W. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 4, 1966. Contract W-7405-eng-48. 11p. (CONF-661114-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Digital Equipment Computer User's Society Meeting, Berkeley, Calif.

A series of programs written to process, on a PDP-5 computer, data from an experiment measuring pi-mesic-produced x-rays at the 184-Inch Cyclotron are described. The programs display data from an A/D converter on an oscilloscope, record it on magnetic tape, and provide feedback to the gain and bias settings of the data amplifier for stabilization of the system transfer function. One program accepts 2048 incoming channels, the other accepts 4096. A third program permits analysis of data previously stored on tape, the area and centroid of a given peak being calculated using a light pen to set the peak boundaries and background line. (auth)

13354 (UCRL-50152) STABILITY OF THE ELECTRONIC CONFIGURATION AND COMPRESSIBILITY OF ELECTRON ORBITALS IN METALS AS DETERMINED FROM SHOCK-WAVE DATA. Royce, E. B. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 21, 1966. Contract W-7405-eng-48. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Atomic radii at 0°K are calculated from shock-wave equation-of-state measurements on metals and are compared with the radii of various free-atom electron orbitals obtained from Hartree–Fock calculations. For metals from the long periods of the periodic table having less than half-filled conduction bands, the Z dependences of the experimental atomic radii and the Hartree–Fock free-atom orbital radii are found to be essentially identical at all pressures, making possible the identification of the dominant contribution to the effective interatomic potential. In these metals it is found that the presence of a significant population in the d band appears to result in a low compressibility. An unusually high compressibility observed for the normally trivalent rare-earth metals is then taken as evidence of the promotion of a 5d electron to a 4f shell under compression. Interactions between closed electron shells in metals are estimated from the experimental equations of state of the rare gasses and isoelectronic alkali halides. In the experimental pressure range, interactions between these closed-shell cores are found to be important only for the rare earth metals, where an observed stiffening of the Hugoniot is identified as resulting from core interactions. The limits of validity of Thomas–Fermi-like equation-of-state calculations are discussed. (auth)

13355 (SLAC-Trans-52) RADIATIVE EFFECTS IN COLLIDING-BEAM EXPERIMENTS. Baier, V. N.; Fadin, V. S.; Khoze, V. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt (Stanford Linear Accelerator Center, Calif.), from Preprint 52. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The emission of a photon of arbitrary energy during large-angle scattering of high-energy electrons is discussed. The cross sections for this process are found for the case when the photon is emitted into a narrow cone along the direction of motion of the particles. A general formula is obtained in the logarithmic approximation for the radiative corrections to the electron–electron scattering cross section. A cross section for the emission of soft photons is calculated for arbitrary electron scattering angles. (auth)

13356 A STUDY ON ZEEMAN TRANSITION OF OPTICALLY ALIGNED ALKALI METAL VAPOR. Ando, Shigeru; Kubo, Takahiro (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 5: 397-410(Oct. 1964).

Hyperfine structures of paramagnetic response absorptions were observed by the optical pumping technique in Cs, ^{87}Rb, and ^{85}Rb vapor. With comparatively high magnetic fields, all Zeeman transitions of ground state $^2S_{1/2}$ were separated completely in ^{87}Rb and ^{85}Rb. The intensity distribution of the hyperfine structures was interpreted by the rate equations. The hyperfine structures of Zeeman transitions of the ground state of ^{133}Cs, ^{87}Rb, and ^{85}Rb showed good agreement with the Breit–Rabi formula in the magnetic field range from 0.5 to 20 G. The population distributions in optically aligned Rb vapor were roughly interpreted by the rate equations without consideration of the spin exchange. To explain the population distribution in the lower F state, it was necessary to consider the spin exchange because of the existence of the critical temperature. Some unsolved problems are discussed. The rate equations should be solved in consideration of the spin exchange, the differences in related characteristics between the buffer gas-filled cell and the vacuum cell should be clarified, the values of T_1 of ^{87}Rb and ^{85}Rb should be observed individually, and the cross section of the spin exchange between ^{87}Rb and ^{85}Rb should be measured. (BBB)

13357 ON THE SOLUTION OF THE QUANTUM MECHANICAL TWO-ELECTRON PROBLEM BY DIRECT CALCULATION OF THE NATURAL ORBITALS. III. REFINED TREATMENT OF THE HELIUM ATOM AND THE HELIUM-LIKE IONS. Ahlrichs, R.; Kutzelnigg, W.; Bingel, W. A. (Univ., Goettingen, Ger.). Theor. Chim. Acta, 5: 289-304(1966).

Natural orbitals (NO) and natural expansion coefficients for the ground states of the He atom and some isoelectronic ions were calculated directly as numerical self-consistent solutions of integro-differential equations derived previously. These new applications differed from previous ones insofar as larger and more flexible sets as one-electron functions were used and as certain simplifications were no longer made. The wave functions and energies obtained competed with the best configuration interaction results known so far and were obtained in an easier and more straight-forward way. Plots of the NO's showed that different NO's of the same state are localized in the same region of space. Special attention was given to the problem of the convergency of the natural expansion and to the role of the correlation potential, which was defined as the difference between the effective one-electron Hamiltonians for the 1st (strongly occupied) NO and the Hartree–Fock (HF) orbital respectively. If this correlation potential is taken into account using an iterative procedure, it is possible to obtain better approximations to the first NO than the HF orbitals. In terms of the energy it is (except for the H^--ion) irrelevant whether or not the difference between the 1st NO and the HF orbital is ignored. (BBB)

13358 THERMODYNAMICAL APPROACH TO SPIN AND LATTICE TEMPERATURE. Montelatici, V. (CNEN, Frascati, Italy). Nuovo Cimento (10), 47B: 104-12(Jan. 11, 1967).

In a previous article the dynamic polarization of a system with spins $S = I = \frac{1}{2}$ using a thermodynamic treatment was studied. In this article the lattice and spin temperatures are deduced. Also, in the case where the temperatures of the two kinds of spin are equal, the conditions on the relaxation times and on the energy levels have been worked out. (auth)

13359 SPECTRA AND ANGULAR DISTRIBUTIONS OF PHOTOELECTRONS FROM ATOMS AND MOLECULES. Berkowitz, J. (Argonne National Lab., Ill.); Ehrhardt, H.; Tekaat, T. Z. Phys., 200: 69-83(1967). (In German).

The photoelectron energy spectra produced by the impact of 584 Å photons on the gases Kr, H_2, N_2, O_2, CO, NO, and several alkanes are reported. The angular distribution of photoelectrons corresponding to the simultaneous formation of specific electronic states of the ion was measured in the range 30 to 130°. A preference for electron ejection in the direction of light propagation is shown in the formation of the electronic ground states of NO^+ and O_2^+. Both involve the ejection of an electron from a π_g orbital. The onset energies for the various electronic states were obtained with a resolution of ca. 40 MeV. The relative transition probabilities for formation of various electronic states in a given molecular ion, as well as the Franck–Condon factors within specific states were obtained. Similar experiments with the alkanes (methane, ethane, propane, and n-butane) reveal directly the existence of widely separated electron states (or grouping of states) in the ion, as well as the probability of forming these states. This energy distribution function, of vital importance to the study of the unimolecular decay of ions, could only be inferred previously by use of a questionable assumption. (auth)

13360 SCATTERING OF COLD NEUTRONS BY POLYCRYSTALLINE BARIUM, STRONTIUM, AND LEAD TITANATES. Solov'ev, S. P.; Kukhto, O. L.; Chernoplekov, N. A.; Zetlyanov, M. G. (Karpov Physicochemical Scientific-Research Inst., Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 2156-62 (Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2699-2708(Sept. 1966).

Measurements were made of the spectra of cold neutrons scattered inelastically by polycrystalline samples of $SrTiO_3$, $BaTiO_3$, and $PbTiO_3$ at room temperature and by a sample of $PbTiO_3$ at temperatures below (470°C) and above (520°C) the Curie temperature. Comparison was made of the data obtained with the known results of optical investigations and, in the case of $BaTiO_3$ and $SrTiO_3$, also with the results of investigations using the inelastic scattering of neutrons. (auth)

13361 DEPENDENCE OF THE SECONDARY ELECTRON EMISSION AND OF THE ELASTIC ELECTRON SCATTERING ON THE THICKNESS OF A BARIUM OXIDE FILM ON TUNGSTEN AT LOW PRIMARY-ELECTRON ENERGIES. Shul'man, A. R.; Bazhanova, N. P. (Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 2235-6(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2797-8(Sept. 1966).

The dependence of the secondary electron emission coefficient and the elastic reflection coefficient on the thickness of a film of barium oxide on W was measured at primary electron energies of 3 to 50 eV. It was found that the limiting value of the depth of emergence of secondary electrons of energies $0 \leq E \leq E_p$ is not affected by the variation of the primary energy from 10 to 50 eV,

and for a well-activated BaO film, it amounts to only 13 to 15 monolayers. The depth of emergence of elastically reflected electrons having energies of 5 to 17 eV is also independent of E_p and is equal to about 5 monolayers. (A.G.W.)

13362 CRITICAL ANGLES FOR CHANNELING OF H^+, D^+, AND He^+ IONS IN SINGLE CRYSTAL GOLD FILMS IN THE ENERGY INTERVAL 1 TO 17 keV. Andreen, C. J.; Hines, R. L. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 24A: 118-20 (Jan. 16, 1967).

The critical angles for channeling are obtained from measurements of transmitted ion intensity in the forward direction through gold crystal foils as a function of foil orientation. The results agree with theoretical predictions for the low energy region. (auth)

13363 SPECTRA OF PRIMARY AND SECONDARY ELECTRONS IN MATERIAL IRRADIATED BY FAST ELECTRONS. Harder, D. (Univ., Wuerzburg, Ger.). pp 140-54 of STI-DOC-10/58.

Recent experimental and theoretical data on energy spectra of primary and secondary electrons in material irradiated by fast electrons are reported. The geometrical situation encountered when fast electrons are penetrating a thick layer of matter is illustrated by a bubble chamber photograph of their tracks. Three typical spectrometer arrangements are also illustrated and the use of a spectrometer with plastic scintillator, collimator, and pulse-height analyzer for angle-dependent measurements of the differential flux of fast electrons in different depths of material is described and geometrical problems are discussed. Results are reported from measurements of the spectra of electrons with primary energies between 10 and 20 MeV behind carbon, water, and lead. A Faraday cup arrangement was used to determine the number of secondary electrons in different depths. The theoretical determination of electron spectra and radiobiological implications of the spectral change are also discussed. It was concluded that the relative increase in the medium energy region of the spectrum with increasing depth is the cause of the depth dependence of RBE with certain reactions. The radiobiological consequences of this statement are discussed. (24 references.) (C.H.)

13364 ION IMPLANTATION. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. J., 3: No. 2, 69-72(Feb. 1967).

Implantation of ions from a sputtering source into a solid is shown with a beam directed vertically down to a solid represented as a lattice of atoms. Electrons from the hot tantalum filament ionize the argon gas to form a plasma from which positively charged atoms are attracted to the sputtering electrode where they eject neutral atoms. These atoms are ionized in the plasma, extracted as a 10,000-volt beam and separated magnetically from the argon. The difference between random and channelled trajectories is shown. The random ion collides with a succession of atoms in the solid and comes to rest as an interstitial impurity. The recoiling solid atoms initiate collision cascades and create radiation damage in the form of both interstitial and vacancy defects, while sputtering occurs if the cascade intersects the surface. The channelled ion passes between rows of lattice atoms without collision; this results in increased range and much reduced radiation damage. (auth)

13365 A DETERMINATION OF THE GAP AT THE FERMI SURFACE OF THE ELECTRON MOMENTUM DISTRIBUTION ON THE BASIS OF TWO-QUANTUM POSITRON ANNIHILATION. Sedov, V. L. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 169: 1058-9(1966). (In Russian).

The gap at the Fermi surface of the momentum distribution of positron-annihilation γ rays is shown to have an additional contribution due to the interaction of the positron with the electronic medium surrounding it. The calculation is done for the case of a completely condensed electron system, using Green's function techniques. The probability of the two-photon transition is found to equal the sum of four terms, each having a well-defined physical meaning. One term describes the probability of positron annihilation, ignoring interparticle interactions. The second term describes the interactions of the electrons with one another. The third term arises from the interaction of the positron with the surrounding electronic medium. Finally, the fourth term accounts for interactions between the two annihilated particles. It is found that the effect of the third term—the positron–electron interactions—increases with the radius of the electronic unit sphere. A further conclusion is that the experimentally observed gap in the γ-ray momentum distribution must be smaller than that which corresponds to the gap in the complete electron momentum-distribution function. (ATD)

13366 ELASTIC ENERGY LOSSES OF CRYSTAL-SCATTERED ELECTRONS. Boersch, H.; Wolter, R.; Schoenebeck, H. (Technische Univ., Berlin). Z. Phys., 199: 124-34(1967). (In German).

Elastic energy losses due to scattering of fast electrons (20 to 40 keV) by crystals into large angles ($\geq 45°$) are experimentally and theoretically investigated. Energy losses up to a few electron volts appear, which depend on the mass of the atoms composing the crystal, on the scattering angle, and on the primary energy of the electrons. These results agree with the assumption of elastic scattering by single atoms and not by the crystal as a whole. The width of the energy losses increases with the energy loss itself, and with the temperature of the crystal. In a first theoretical approximation this effect can be explained by the thermal motion of free atoms. (auth)

13367 ENERGY DEPENDENCE OF ION–MOLECULE REACTIONS WITH NEGATIVE IONS. Vogt, D.; Neuert, H. (Institut fuer Experimentalphysik, Hamburg). Z. Phys., 199: 82-7(1967). (In German).

Some ion–molecule reactions with negative ions (OH^- and NH_2^-) were studied using a primary ion source, in which the negative ions were produced by electron impacts with electron resonance capture, and a secondary ion source, in which the primary negative ions produced ion–molecule reactions with formation of secondary negative ions. The secondary ions were magnetically analyzed and registered by a multiplier. Cross sections of the reactions as a function of the energy of the primary ions were measured in the region of low energies up to about 20 eV. In the low-energy region the cross sections rapidly decrease with increasing energy $\sim E^{-1/2}$ as was the case with the energy dependence of the cross section of charge-transfer reactions with negative ions at the same energies. (auth)

13368 SOURCE FOR POLARIZED LITHIUM NUCLEI. Ebinghaus, H.; Holm, U.; Klapdor, H. V.; Neuert, H. (Institut fuer Experimentalphysik, Hamburg). Z. Phys., 199: 68-81(1967). (In German).

A source for nuclear polarized lithium-6 and -7 ions was built following the method of separation of the atomic hyperfine states in a strong inhomogeneous magnetic sextupole field and ionization of the selected atoms by electron bombardment in a weak homogeneous field. The velocity distribution of the atomic beam formed by a Laval nozzle and the focussing properties of the sextupole magnet were determined using a mechanical velocity selector. After separation of the two isotopes the ion beam has an intensity of 10^{-9} ampere. As no background of unpolarized lithium ions was found, a vector polarization of $(32 \pm 1)\%$ and $(24 \pm 1)\%$ for lithium-6 and -7 and a tensor polarization of $(-32 \pm 1)\%$ for lithium-6 can be expected. (auth)

13369 LOW-ENERGY, LARGE-ANGLE ELECTRON-IMPACT SPECTRUM OF ETHYLENE. Doering, John P. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 46: 1194-6(Feb. 1, 1967).

The electron-impact spectrum of ethylene was measured at primary energies of 35, 50, and 70 eV and a fixed scattering angle of 90°. The most intense inelastic peak was found to be 8 eV. This peak corresponds to a number of unresolved allowed transitions observed in a vacuum-ultraviolet absorption spectrum. A peak was observed at 4.6 eV, which was assigned to a forbidden singlet–triplet transition. The 6.5-eV "ultraviolet mystery band" transition was not observed. Neither was any peak observed in the spectrum that could be assigned to a large inelastic process at the ionization limit. (auth)

13370 ENERGY DISTRIBUTION OF ENERGETIC ATOMS IN A GASEOUS MEDIUM. I. ELASTIC SCATTERING OF PARTICLES BY SPHERICAL POTENTIALS OF THE FORM $V(r) = (A_1/r^{s_1}) + (A_2/r^{s_2})$. Baer, Michael; Amiel, Saadia (Soreq Nuclear Research Center, Yavne, Israel). J. Chem. Phys., 46: 1044-53(Feb. 1, 1967).

The energy distribution function n(E) for energetic particles in a gaseous medium is treated (classically) assuming elastic scattering governed by a two-term spherical potential of the form $V(r) = (A_1/r^{s_1}) + (A_2/r^{s_2})$. It is found that in the energy interval from 1 MeV to 1 keV, n(E) differs from that computed for a single-term potential, but it makes almost no difference whether the second (long-range) component is of an attractive or repulsive nature. In the low-energy range (<1 keV), if the long-range component is repulsive it almost completely screens the short-range one (which is always assumed to be repulsive). If it is attractive it lowers the values of n(E) in comparison with those obtained with a repulsive long-range term. The calculations also show that n(E) is almost independent of the initial energy of the incoming particles. The results can be applied to the calculation of the yields of chemical reactions caused by energetic atoms such as fission fragments. One of the implications that emerges is that the yields of the reactions would not be influenced by the initial spectrum of the energetic atoms, since this has practically no effect on n(E) provided that the atoms behave like material points. (auth)

13371 IONIZATION CROSS SECTIONS, CHARGE-TRANSFER CROSS SECTIONS, AND IONIC FRAGMENTATION PATTERNS OF SOME PARAFFINS, OLEFINS, ACETYLENES, CHLOROALKANES, AND BENZENE WITH 40 TO 100-keV PROTONS. Collins, J. G.; Kebarle, P. (Univ. of Alberta, Edmonton). J. Chem. Phys., 46: 1082-9(Feb. 1, 1967).

The simple and charge-transfer ionization cross sections for Kr, Ne, N_2, CH_4, C_2H_4, and n-C_4H_{10} were measured with 40- to 100-keV protons. The simple ionization cross sections are almost constant in this range, while the charge-transfer cross sections are roughly 40% of the total ionization at 40 keV and decrease to about 10% at 100 keV. The relative ionization cross sections (both simple and charge-transfer) of a variety of molecular compounds were measured with 100-keV protons and found to be linearly related to the polarizabilities. The mass spectra of a number of hydrocarbons were measured with 50- and 100-keV protons. The mass spectra are qualitatively very similar to spectra obtained with electrons of the same velocity (55 eV for 100-keV protons). This is to be expected from a qualitative extension of the Bethe–Born equation to ionization of molecular electrons. Since the mass spectra change little with velocity the American Petroleum Institute (A.P.I.) fragmentation patterns with 50- to 75-V electrons are a good guide to ionization by any (singly) charged particle with velocity higher than 10^8 cm/sec. Fragments of high appearance potentials and doubly charged ions are considerably more abundant in the 40- to 100-keV proton spectra than at higher proton energies or in the electron-impact spectra. Conclusions can be made as to the charge-exchange mass spectra produced by particles with velocities in the range 10^8 cm/sec. These mass spectra are very different from charge-transfer spectra obtained at low primary ion energies. Thus there is little dependence on the recombination energy of the primary ion. The charge-transfer spectra seem not very different from the spectra produced by simple ionization. This means that the distribution of internal energies imparted to the new ion cannot be very different from that in pure ionization. (auth)

13372 INTENSITY SHIFT IN SMALL-ANGLE MULTIPLE SCATTERING OF TRANSVERSELY POLARIZED ELECTRONS. Ernst, V. (Univ. of Pittsburgh). Nucl. Phys., A94: 528-36 (1967).

Mott asymmetry in repeated small-angle scatterings of transversely polarized electrons by heavy atoms produces a shift in the distribution of the particles emerging from the scattering foil. An experiment for the measurement of this effect is proposed, and possible applications as a means of gaining information on the scattering law at small angles and as a detector for the transverse polarization of free electrons are discussed. Numerical data are given for electron energies between 100 and 300 keV. (auth)

13373 COMMENTS ON THE ABSORPTION COEFFICIENTS OF FAST ELECTRONS MEASURED FROM FILTERED AND UNFILTERED ELECTRON MICROSCOPE IMAGES. Cundy, S. L. (Cambridge Univ., Eng.).; Metherell, A. J. F.; Whelan, M. J. Phys. Lett., 24A: 120-1(Jan. 16, 1967).

It is shown that the difference between the mean absorption coefficient measured from the intensity oscillation of a zero-loss electron microscope dark-field image and that measured from the ordinary image is the reciprocal of the mean free path for inelastic scattering. (auth)

13374 ION DENSITY PROFILES BEHIND SHOCK WAVES IN AIR. Frohn, A.; de Boer, P. C. T. (Cornell Univ., Ithaca, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 261-4(Feb. 1967).

Experimental results are reported for the ionization rate behind shock waves of Mach numbers between 7.2 and 9.2. The results were obtained using a hollow, total collector probe in combination with a 38-mm-dia, stainless steel shock tube designed to minimize the impurity level in the test gas. Good agreement was obtained with a theoretical result based on Lin and Teare's rate equations. Equilibrium ion densities in good agreement with theory were measured behind shocks of Mach number 7.2 to 12.8, with initial pressures between 0.5 and 40 mm Hg. The effects on the measurements of deviations from ideal shock tube flow were determined to be small. Ion densities measured range from 10^8 to 10^{12} cm^{-3}. At the higher ion densities there are large space charge effects inside the probe. Under these circumstances, proper operations of the probe still could be obtained provided the collector potential was not made too high. This implies that the mobility of the NO ions collected must be rather large. (auth)

13375 ION EXTRACTOR SYSTEM DESIGN. Staggs, John F.; Richley, Edward A.; Gula, William P. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 359-60(Feb. 1967).

Ion extractor systems for electrostatic thrusters have been designed, in general, by using digital computer programs, or analog techniques. A means is described for analyzing an ion extractor system that uses the salient features of both these methods and eliminates the need for certain complex equipment formerly required with the analog approach. (M.O.W.)

13376 EQUATIONS OF MOTION OF NUCLEAR MAGNETISM. Robertson, Baldwin (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 153: 391-403(Jan. 10, 1967).

A general formalism from a previous paper is applied to derive an exact equation of motion for the total magnetic moment M of a system containing a single species of nuclear spins in an arbitrarily time-dependent external magnetic field H. Then, the equation is simplified for kT large compared with γH and compared with microscopic anisotropic spin energies but not necessarily compared with microscopic exchange energies. Only this high-temperature approximation is needed for the equation to reduce to $dM/dt = \gamma M \times H - \int_0^t K(t,t') \cdot [M(t') - \chi_0 H(t')]dt'$, which is valid for systems with arbitrarily long correlation times. The system is assumed to be in equilibrium for $t < 0$, but it may deviate arbitrarily far from equilibrium for $t > 0$. The kernel K is a dyad that depends upon T and upon H but not upon M. The equation is capable of describing nonexponential relaxation and therefore non-Lorentzian resonance line shapes. For arbitrarily large times t, it is valid for, but not restricted to, a many-spin system with strong dipole–dipole interactions between spins in a rigid lattice and with spin $\geq \frac{1}{2}$. For a nonrigid lattice, no assumption is made that the lattice is or is not in equilibrium, that it is a thermal bath, or that the density matrix may be factored. Instead, in order to simplify the formal expression for K and thus the solution of the equation, slowly varying-temperature, high-temperature, and high-frequency approximations are made so that $K(t,t')$ becomes a function of $t-t'$ only. Finally, the approximation of neglecting the dependence of K on H_1 is made, so that K becomes diagonal and equal to a sum of terms each consisting of a simple oscillatory factor times a function that may be interpreted as the correlation function of a stationary random process. The corresponding correlation times need not be short, but for comparison with previous formalisms a short-correlation-time approximation is also made. (auth)

13377 STOPPING POWER OF Be, Al, Cu, Ag, Pt, AND Au FOR 5- TO 12-MeV PROTONS AND DEUTERONS. Andersen, H. H.; Hanke, C. C.; Soerensen, H.; Vajda, P. (Atomic Energy Commission, Risoe, Denmark). Phys. Rev., 153: 338-42 (Jan. 10, 1967).

Recent measurements on stopping power of aluminum have been continued with the stopping materials Be, Cu, Ag, Pt, and Au. The method of measuring stopping powers utilizing a thermometric compensation technique working at liquid-helium temperature has been used. Results are obtained with a standard deviation of 0.3%, and agree with other published experimental results and with Bichsel's tabulated values within their stated errors. (auth)

13378 HIGHER APPROXIMATION OF THE MOLIERE THEORY OF ELECTRON MULTIPLE SCATTERING. Widder, F. (Univ., Graz). Acta Phys. Austr., 24: 135-8(1966). (In German).

The discrepancies between theory and experimental results in the multiple scattering of 15.7-MeV electrons in 18.66 mg/cm^2 thick gold foils led to the study of whether higher approximations in the Moliere scattering formula would bring better agreement. The numerical results show that previously unused development terms of the Moliere formula at average scattering angles can yield measurable contributions to the total distribution. (J.S.R.)

13379 ELASTIC SCATTERING OF MESOATOMS ON HYDROGEN AND ON DEUTERIUM: DETERMINATION OF THE TOTAL SPIN STATE OF THE μp MESOATOM. Alberigi Quaranta, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Bertin, A.; Matone, G.; Palmonari, F.; Placci, A.; Dalpiaz, P.; Torelli, G.; Zavattini, E. Nuovo Cimento (10), 47B: 72-91 (Jan. 11, 1967).

The elastic scattering cross section of thermalized μp mesoatoms against hydrogen molecules (T = 300°K) was measured. The experimental results are in agreement with the predictions obtained by Cohen et al., and by Zel'dovich and Gershtein. The elastic scattering cross section of thermalized μd mesoatoms against deuterium molecules was also measured. (auth)

13380 MEASUREMENT OF THE TRANSFER RATES OF MUONS FROM HYDROGEN TO XENON AND SOME OTHER MONOATOMIC ELEMENTS. Alberigi Quaranta, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Bertin, A.; Matone, G.; Palmonari, F.; Placci, A.; Dalpiaz, P.; Torelli, G.; Zavattini, E. Nuovo Cimento (10), 47B: 92-103(Jan. 11, 1967).

The rates of the reaction $\mu p + Y \rightarrow \mu Y + p$ where negative muons are transferred from a μp mesic atom to a monoatomic element Y

mixed with gaseous hydrogen at 26 atmospheres were measured. The elements Y added in known proportions were Xe, Ne, Ar, and Kr. The results of the measurements are compared with those obtained by other authors and with theoretical predictions. (auth)

13381 LOWER BOUNDS TO ENERGIES FOR GAUSSIAN WAVE FUNCTIONS: STUDIES OF THE HYDROGEN-ATOM GROUND STATE. Schwartz, M. E. (Oxford Univ.). Proc. Phys. Soc. (London), 90: 51-4(Jan. 1967).

To test the possibility of extending lower-bound energy determinations to molecules by the methods of Temple, Weinstein, and Stevenson and Crawford, lower bounds for the energy of the 1s ground state of the H atom are computed for Gaussian based wave functions, for which the calculation of the average value of the square of the Hamiltonian $\langle \mathcal{H}^2 \rangle$ is not too difficult. Extensive optimized variational wave functions are used. Even for this optimum situation the results are very poor, although a ten-term wave function gives an upper bound error of only 10^{-6} A.U., the smallest corresponding lower bound error is still more than 0.032 A.U. (20 kcal $mole^{-1}$). Examination of components of $\langle \mathcal{H}^2 \rangle$ and the energy variance $\langle \mathcal{H}^2 \rangle - \langle \mathcal{H} \rangle^2$ shows that the poor features of the Gaussian function are magnified when $\langle \mathcal{H}^2 \rangle$ is determined, and that convergence is too slow for practical use of the approach. It is also noted that Gaussian atomic wave functions will not give good values for relativistic corrections to energies. (auth)

13382 SEARCH FOR A SHIFT IN THE TRANSVERSE ELECTROMAGNETIC MASS OF THE ELECTRON. Guttrich, G. L.; Billman, K. W. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 24A: 53-5(Jan. 2, 1967).

An experimental search was made for a frequency shift produced by conducting-plate confinement of the cesium beam in an atomic clock. The ratio of experimental to theoretical plate separation dependence is -0.023 ± 0.036, consistent with no shift. (auth)

13383 CONTRIBUTION OF SINGLE SCATTERING AND DIFFUSION TO THE BACKSCATTERING OF MONOENERGETIC ELECTRONS. Thuemmel, H.-W. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Z. Phys., 198: 263-76(1967). (In German).

The previously known elementary theory for calculation of the backscattering coefficient for an electron bundle perpendicular to the two-dimensional scattering medium and a 2π observed geometry was expanded by consideration of the absorption of the electrons on the path back from the scattering depth to the target surface. Therefore it was possible, after addition of the absorption-corrected contribution to diffusion and individual scattering to the experimental value of the back-scattering coefficient to quantitatively declare: the diffusion portions for $E_0 = 0.1$, 0.7, and 4.0 MeV amount to more than 50, 70, and 80%. (tr-auth)

13384 ANGULAR AND ENERGY DISTRIBUTION OF IONS REFLECTED FROM COPPER SINGLE CRYSTALS. Karpuzov, D. S.; Eltekov, V. A.; Yurasova, V. E. (Lomonosov State Univ., Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 1726-32(Jan. 1967).

Translated from Fiz. Tverd. Tela, 8: 2173-81(July 1966).

Trajectory modeling was used to determine the reflection of 3-keV copper ions and of 2.2-keV argon ions from a copper single crystal. The case of normal incidence of ions on the (100) face was considered. The angular and energy distribution patterns were obtained for the reflected ions and the relationship between the patterns was established. It is shown that the maxima in the angular and energy distributions are due to ions reflected after a definite number of collisions with the lattice atoms. (auth)

13385 REMARKS ON THE KINETIC EJECTION OF ELECTRONS FROM A COPPER MONOCRYSTAL BY ARGON IONS WITH ENERGY 20 TO 80 keV. Drentje, S. A. (Rijksuniversiteit, Groningen, Netherlands). Phys. Lett., 24A: 12-17(Jan. 2, 1967).

The regular lattice structure is introduced in Parilis' theory of electron emission by considering the "shadow" behind surface atoms. The energy dependence of the widths of the minima in $\delta(\Psi)$ curves (Ψ is bombarding direction) is $\propto E^{-\frac{1}{2}}$, in accordance with experiments. (auth)

13386 CONCERNING THE DEPENDENCE OF THE SPUTTERING RATIO ON ION ENERGY. Martynenko, Yu. V. Soviet Phys.-Solid State (Engl. Transl.), 8: 1678-9(Jan. 1967).

Translated from Fiz. Tverd. Tela, 8: 2109-11(July 1966).

The dependence of the sputtering ratio on ion energy is discussed. The effect of multiple collisions of the incident ions with target atoms is taken into account. (auth)

13387 BREMSSTRAHLUNG AND TRANSITION RADIATION FROM SILVER FOILS BOMBARDED BY NONNORMAL-INCIDENCE ELECTRONS. Cram, L. S.; Arakawa, E. T. (Oak Ridge National Lab., Tenn.). Phys. Rev., 153: 455-9(Jan. 10, 1967).

The radiation emitted by self-supporting Ag foils 700 to 1700 Å in thickness was investigated as a function of angle of electron incidence, foil thickness, and degree of polarization. For a foil 700 Å in thickness, the peak at 3300 Å characteristic of transition radiation was found in the emission spectrum when the foil was bombarded by normally incident electrons ($\theta_i = 0°$). The wavelength at which the peak appeared increased monotonically with increasing angles of electron incidence until it appeared at $\lambda = 3400$ Å for $\theta_i = 87°$. For a foil 1680 Å in thickness, the transition radiation peak at $\lambda = 3300$ Å was found to decrease in intensity as θ_i increased from normal incidence and finally disappeared at $\theta_i = 80°$. For $\theta_i > 75°$, another peak appeared at 3500 Å, which increased in intensity for $\theta_i > 85°$, and finally became an intense peak at $\lambda = 3600$ Å, for $\theta_i = 89°$. The dependence of the peak at 3500–3600 Å for large angles of electron incidence on θ_i, electron energy, and polarization agrees with details predicted by a model due to Howe and Ritchie based upon the production of bremsstrahlung in a semi-infinite slab, and leads to the conclusion that the optical emission observed from Ag foils bombarded by grazing-incidence electrons is bremsstrahlung, and not radiation from the decay of surface plasmons, as hypothesized by Boersch et al. (auth)

13388 X-RAY ATTENUATION-COEFFICIENT MEASUREMENTS. McCrary, J. H.; Plassmann, Elizabeth H.; Puckett, J. M.; Conner, A. L.; Zimmermann, G. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 153: 307-12(Jan. 10, 1967).

X-ray attenuation coefficients were measured in the energy range 25 to 130 keV for the following elements: Be, C, Mg, Al, S, Ti, Fe, Ni, Cu, Zn, Zr, Nb, Mo, Ag, Sn, La, Gd, Hf, W, Au, Pb, Th, U, and Pu. Narrow-beam collimation was used with a Bragg diffraction monochromator. Experimental errors were less than 2% for most of the measurements. (auth)

13389 ELECTRON–POSITRON DIFFERENCES IN MULTIPLE SCATTERING. De'Munari, G. M. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan); Mambriani, G.; Faraone, G. Phys. Rev., 153: 388-91(Jan. 10, 1967).

It is shown that the maximum in the energy plot of the difference of the multiple-scattering deflections experienced by low-energy electrons and positrons can be qualitatively obtained by a direct Coulombic approach, although it is not explained by the most accurate theory of multiple scattering. From this a "transfer" method is developed by means of which, from the experimental multiple-scattering values for an element, one can obtain those for all other elements with $Z \ll 137$. (auth)

13390 DIRECT COMPARISON OF THE PENETRATION OF LIQUIDS BY POSITRONS AND ELECTRONS. Takhar, P. S. (Royal Military Coll., Kingston, Can.). Phys. Lett., 24A: 169-70(Jan. 30, 1967).

The penetration of 1.88-MeV positrons and 1.77-MeV electrons in liquids show much larger differences than those in solids. The positron–electron difference in penetration of benzene is 72%, water 78%, and toluene 88%. (auth)

13391 RADIATIVE CORRECTIONS TO INELASTIC ELECTRON SCATTERING. Bartl, A.; Urban, P. (Univ., Graz). Acta Phys. Austr., 24: 139-46(1966).

In all scattering experiments with electrons it is important to know the radiative corrections up to a certain accuracy. On the other hand the corrections depend very strongly on the experimental arrangement. The radiative corrections are calculated for the process $e + p = e + n + \pi^+$, but the formulas can be used for all experiments with similar kinematics. Radiation from the electrons as well as from the other charged particles is taken into account. (W.D.M.)

13392 GENERALIZED FLUCTUATION–DISSIPATION THEOREM. Stahl, A.; Bausch, R.; Janssen, H. K. (Technische Hochschule, Aachen). Phys. Lett., 24A: 171-2(Jan. 30, 1967).

It is shown that a generalized form of the fluctuation–dissipation theorem may be considered as a simple probabilistic relation within a theory of probability operators. This theory is gained by extending the notion of density operators. (auth)

13393 LOW-ORDER PROTON CHANNELLING. Machlin, E. S. (Columbia Univ., New York). Phys. Lett., 24A: 173-4(Jan. 30, 1967).

Computer studies of proton channelling through ultra-thin crystals of gold reveal how to design experiments to measure the potential experienced by the channelling proton and to relate the stopping power to the path of the proton in the channel. (auth)

13394 FORMULA FOR THE BINDING ENERGIES OF ATOMIC IONS. Pruski, S. (Copernicus Univ., Torun, Poland). Phys. Lett., 24A: 174-5(Jan. 30, 1967).

The lower bound for the ground state energy of an arbitrary (Z,N)-ion with $Z/(N-1)$ integer is expressed in terms of N lowest energy levels of an associated (Z',N')-ion with $Z' = Z(N-2)/(N-$

1) and N' = N − 1. The formula generalizes and refines that of Bopp (1959). (auth)

13395 NEW LAW IN ELECTRODYNAMICS. Costa de Beauregard, O. (Institut Henri Poincare, Paris). Phys. Lett., 24A: 177-8(Jan. 30, 1967).

As a consequence of the "Laplace" force RE × β applied to a moving magnetic charge R, a varying dipole of moment M undergoes a force E × dM/dt, and a slowly varying current of intensity i a force (di/dt)∮Vδl, where V denotes the scalar potential. (auth)

13396 THIRD VIRIAL COEFFICIENT OF ^{4}He FOR LENNARD–JONES (6-9) POTENTIAL IN THE TEMPERATURE RANGE FROM 18° K TO 295° K. Tempel, H. U.; Wolf, M. (Technical Univ., Dresden). Phys. Lett., 24A: 187-8(Jan. 30, 1967).

Using the technique of Kihara the third virial coefficient including first quantum correction for the Lennard–Jones (6–9) potential with parameters due to Haberlandt is calculated. (auth)

13397 THERMAL DIFFUSE SCATTERING OF LOW-ENERGY ELECTRONS. Huber, D. L. (Univ. of Wisconsin, Madison). Phys. Rev., 153: 772-9(Jan. 15, 1967).

The thermal diffuse scattering of low-energy electrons is calculated in the high-temperature limit using the kinematical approximation. It is assumed that the electrons are scattered by the surface layer and that the thermal motions of the target can be approximated by the vibrations of an isotropic elastic continuum. It is found that the intensity of the scattered beam is inversely proportional to the perpendicular distance from the tip of the scattering vector to the nearest reciprocal lattice rod. It is shown that the effect of the free-surface boundary conditions is to double (approximately) the intensity without significantly changing the diffraction pattern. In the vicinity of the (00) rod, nearly half the intensity comes from the Rayleigh surface mode. Brief comparisons are made with experiment and with other theoretical treatments. (auth)

13398 DETERMINATION OF THE ELECTRON-SCATTERING CROSS SECTION IN DEGENERATE SEMICONDUCTORS FROM LOW-FIELD MAGNETORESISTANCE MEASUREMENTS. Benford, Gregory; Dworin, Lowell (Univ. of California, San Diego, La Jolla). Phys. Rev., 153: 901-12(Jan. 15, 1967).

The usefulness of low-field, low-temperature ($\omega\hbar/\epsilon_F \ll 1$, $k_BT/\epsilon_F \ll 1$) magnetoresistance measurements for the determination of the electron-scattering cross section in semiconductors in the "metallic" regime ($n_e \cong 10^{18}$ electrons/cm^3 for InSb) is pointed out, and specific application of the method is made for the case of n-type InSb. The impurity electrons are assumed to be nearly free, scattering weakly from the assumed randomly distributed spherically symmetric impurity centers. It is possible to compute the low-field transport coefficients from the solution of the transport equations. In this, a knowledge of the effective mass m, the effective g value, and the scattering matrix $t_{kk'}(\epsilon_{k\sigma})$ for an electron of spin σ scattering from a single impurity center in the absence of a magnetic field (but including the spin energy) is required. If the momentum dependence of $t_{kk'}(\epsilon_{k\sigma})$ is neglected, one can express the conductivity tensor completely in terms of the first three coefficients $r_l(k_F,\epsilon_F)$ (l = 0, 1, 2) and their derivatives with respect to k_F of an expansion of the differential cross section in Legendre polynomials. A determination of these parameters is made using the zero-field mobility and the transverse magnetoresistance measurements of Isaacson, and the adequacy of a screened Coulomb model (pseudo-) potential is discussed. It is expected that additional measurements of electrical and thermal magnetoresistance and magnetothermopower at several electron densities greater than 10^{18} electrons/cm^3 would greatly improve the accuracy with which the parameters may be determined. (auth)

13399 POLARIZABILITY OF THE HYDROGEN MOLECULE. Kolos, W.; Wolniewicz, L. (Univ. of Chicago, Ill.). Contract DA-31-124-ARO-D-447. J. Chem. Phys., 46: 1426-32(Feb. 15, 1967).

A variation perturbation method was employed to calculate the static dipole polarizabilities of the hydrogen molecule. The wavefunction was represented by an expansion in elliptic coordinates including the interelectronic distance. A 54-term expansion was used for the zero-order wavefunction and 34 terms for the first-order corrections. The polarizabilities computed for several values of the internuclear distance ($0.4 \leq R \leq 4.0$) were averaged for various vibrational and rotational states of H_2, HD, and D_2. The results are in a satisfactory agreement with the experimental values. (auth)

13400 DIFFRACTION OF NEUTRONS ON HEAVY WATER. Forte, M.; Menardi, S. (EURATOM-CCR, Ispra, Italy). Nuovo Cimento (10), 46B: 7-12(Nov. 11, 1966).

The existence of big molecular aggregates in the water structure, previously proposed in various models, has been investigated by neutron-diffraction methods, in the case of heavy water. No coherent effect corresponding to an aggregate structure has been found, although the sensitivity of the experiment was fairly high. On the other hand the same negative conclusion was deduced after a calculation of the light scattering (Tyndall effect). (auth)

13401 QUANTUM THEORY OF ATOMS, MOLECULES, AND THE SOLID STATE. Loewdin, Per-Olov (ed.). New York, Academic Press, 1966. 655p. $25.00.

This volume, which is dedicated to J. C. Slater, covers the progress of atomic, molecular, and solid-state theory from 1925 to the present in articles contributed by sixty different authors. A clear picture is given of the impact of Slater's own work as well as an excellent view of recent research. (W.D.M.)

13402 ATOMIC BEAM APPARATUS. (to Varian Associates). British Patent 1,052,398. Dec. 21, 1966. Priority date Apr. 1, 1963, United States.

The invention relates, in general, to atomic beam apparatus and, more particularly, to atomic beam tubes utilized in magnetic hyperfine resonance transition systems. The principal object is to provide an improved form of atomic beam tube incorporating novel magnetic field shaping and forming means along the beam path to prevent or substantially reduce Majorana transitions. (W.D.M.)

13403 SEMI-CLASSICAL MODEL FOR THE COLLISION-INDUCED EXCITATION AND DISSOCIATION OF FAST IONS. Durup, Jean (Laboratoire de Chimie-Physique, Orsay, France). 9p. (CONF-660537–5). DTIE. Gmelin, AED-CONF-66-175-8.

From 14th Annual Conference on Mass Spectrometry and Allied Topics, Dallas.

The collision-induced dissociation of fast ions is treated by a semiclassical model pertinent to the part of the phenomenon due to electronic excitation of the impinging ion. This excitation is calculated as resulting from the absorption of a virtual photon arising from the field of the induced dipole, in analogy with the Fermi–Williams method. The cross sections thus obtained are compared for simple systems with calculations carried out by different authors using first Born approximation. The semiclassical model is shown to give reasonable results in the kilovolt energy range. (auth)

13404 PRODUCTION EFFICIENCIES OF X-RAY EMISSION SPECTRA BY PROTON BOMBARDMENT. Sterk, A. A.; Marks, C. L.; Saylor, W. P. (American Machine and Foundry Co., Alexandria, Va.). 19p. (CONF-660814–2). DTIE. Gmelin, AED-CONF-66-266-1.

From 15th Annual Conference on Applications of X-ray Analysis, Denver.

Production efficiencies for the excitation of characteristic soft x-ray emission spectra by proton bombardment were investigated. Results were obtained for K-, L-, and M-shell lines of various elements as a function of proton energies ranging up to 100 keV. For comparison purposes, helium, nitrogen, and argon ions were also accelerated and used as bombarding particles to yield efficiency data for some of the same spectral lines. The data demonstrate that: (1) the production efficiencies of spectral lines excited by protons are, in the first approximation, dependent on wavelength only and are independent of the atomic shell with which they are associated, and (2) production efficiencies increase with the atomic weight of the bombarding ions for some of the spectral lines investigated. X-ray generation by proton bombardment is a powerful method for producing high-intensity monochromatic radiation for wavelengths above approximately 10 angstroms. The same technique can be used for analytical purposes to determine the concentration of low atomic number elements. (auth)

Cosmic Radiation

Refer also to abstract 13701.

13405 (AD-640495) LABORATORY SIMULATION OF LUNAR LUMINESCENCE. Scientific Summary Report No. 2, March 1965–March 1966. Geake, J. E. (Manchester Coll. of Science and Tech. (England). Dept. of Physics). Apr. 1966. Contract AF 61(052)-798. 14p. (AFCRL-66-665). CFSTI $3.00 cy, $0.65 mn.

Further investigation of the proton-excited luminescence of meteoritic material is reported. The source of the different types of luminescence from the enstatite achondrites was elucidated by neutron-activation analysis, and the characteristic luminescence spectra of different classes of meteorites were investigated. The effect of proton damage both on the efficiencies and on the spectra were investigated; it was also found that

heating produces recovery from damage, and this process is being studied. (auth)

13406 PROPAGATION OF COSMIC-RAY NUCLEI IN INTERSTELLAR SPACE AND THE SOLAR SYSTEM. Durgaprasad, N. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 965-79(Feb. 1, 1967).

The problem of the propagation of cosmic-ray nuclei in interstellar space and the solar system was investigated with special reference to the recent data obtained on the various components of the cosmic radiation, using balloons, satellites, and rockets over the years 1961–1965. Three kinds of source spectra were assumed in the analysis, namely power law spectra in total energy per nucleon, kinetic energy per nucleon, and in rigidity. The constants and the exponents of these spectra were deduced from the high-energy data that are little affected by solar modulation. The effective path length x in g/cm^2 traversed by the nuclei was determined as a function of energy from a study of the variation of charge ratios of nuclei of charge $Z \geq 20$, $Z \geq 10$, $Z = 3$ to 5, and α particles; the energy-dependent fragmentation parameters needed for this purpose were computed from an empirical relation due to Rudstam. It was found that this path length traversed decreased with decreasing energy, consistent with a model $x = \beta c\rho t = \beta x_e$ where x_e is the high-energy value of matter traversed, βc is the velocity of the nucleus, ρ is the average density of matter, and t is the age of the nucleus. Two mechanisms of modulation, namely the heliocentric electric field model and the generalized Parker's model, were used to study the temporal variations and it was found that the generalized Parker's model would explain the intensity variations fairly well over the period considered for all the components of the cosmic radiation using the source spectrum that is a power law in rigidity. The parameters involved in this model thus deduced for various years were found to be consistent with the values deduced by Parker from general dynamical theory of the solar wind and recent space observations. (auth)

13407 LOW-ENERGY COSMIC-RAY PHOTONS IN ATMOSPHERE. Brini, D.; Ciriegi, U.; Fuligni, F.; Moretti, E. (Bologna Univ.). J. Geophys. Res., 72: 903-13(Feb. 1, 1967).

X-ray detectors with directional properties were launched by balloons to study the soft photon component of the cosmic radiation in atmosphere. The experimental data can be reasonably justified in a quantitative way by assuming that the electron component generates the greatest part of the x rays by bremsstrahlung. The high value of the intensity measured is due to the strong effect of scattering and degradation suffered by higher energy photons. A contribution to the x-ray production by slow neutrons, through the $N^{14}(n,\gamma)N^{15}$ interactions, cannot be excluded; an upper limit of such a contribution may be of the order of few percent. (auth)

13408 MEASUREMENT OF THE CHARGED SPLASH AND REENTRANT ALBDEO OF THE COSMIC RADIATION. Verma, Satya Dev (Univ. of Chicago). J. Geophys. Res., 72: 915-25 (Feb. 1, 1967).

A study of the flux and energy spectrum of the proton and electron components of the splash and reentrant cosmic-ray albedo was made in mid-1965 at balloon altitude over Palestine, Texas (geomagnetic cutoff 4.9 BV). The energy spectrum and the flux of the splash and the reentrant albedo protons were measured in the energy range from 37 to 334 MeV, at an atmospheric depth of about 4 g/cm^2. The two spectra agree within experimental errors. Ray calculated the flux of the reentrant albedo protons at 85 MeV, and obtained 0.41 (m^2 sec ster MeV)$^{-1}$ for a geomagnetic cutoff energy of 1 BeV. His calculation is in agreement with the present measurements. The energy spectrum and the flux of the splash and the reentrant albedo electrons has been measured in an energy range from 10 to 1100 MeV, also at a depth of about 4 g/cm^2. The splash and reentrant albedo electron energy spectra at the top of the atmosphere are well represented by power-law spectra. The two spectra agree within experimental errors. (auth)

13409 MEASUREMENT OF THE PENETRATING RADIATION INTENSITY AT THE MOON'S SURFACE. Vernov, S. N.; Vakulov, P. V.; Gorchakov, E. V.; Logachev, Yu. I.; Lyubimov, G. P.; Nikolaev, A. G.; Pereslegina, N. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 169: 1044-7(1966). (In Russian).

The intensity of cosmic radiation on the moon was measured by a gas discharge counter 6 mm in diameter and 10 mm long erected behind a ~1 g/cm aluminum shielding in Luna-9. The mean counting rate was about 63% of the rate in a free space. The absolute cosmic particle flux recorded was 5.35 ± 0.5 sec^{-2}. Similar recordings by Luna-7 and Luna-8 on October 1965 and December 3 through 6, 1965, respectively, were 5.4 and 5.9 cm$^{-2} \cdot$ sec^{-1}. The reduced cosmic radiation intensity on Feb. 1966 was obviously related to the beginning of the new solar cycle. Thus, the maximum of cosmic-ray intensity was found during Dec. 1965 to Jan. 1966 and the delay of the maximum of cosmic-ray intensity from the maximum of the solar activity recorded for protons with energies exceeding 30 MeV was 1.5 years, which was confirmed by the data obtained by the satellite Zond (Probe)-3, Venus-2, and Venus-3. (R.V.J.)

13410 ELECTRON–PHOTON CASCADE PROCESS IN INTERGALACTIC SPACE. Hayakawa, Satio (Univ. of Nagoya, Japan). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 594-7(1966).

The strong cosmic microwave emission recently discovered plays an important role both in the x-ray emission by the inverse Compton effect and in the γ-ray absorption by pair creation. Since the mean free paths for these two processes are smaller than the cosmic radius, they take place successively in intergalactic space, thus forming a cascade shower. The cascade process results in an increase of the attenuation length of very high-energy γ rays in intergalactic space, and modifies the energy spectrum of electrons and γ rays. However, the intergalactic space is found to be still opaque for γ rays with energies greater than 10^{15} eV. (auth)

13411 STUDIES ON X-AGENT. XLIX. A GREAT CHANGE OBSERVED DURING 1965 IN THE ACTION OF X-AGENT ON COLLOIDAL SOLUTIONS OF BISMUTH-OXYCHLORIDE. Moriyama, Hideo (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 17: 107-13(Aug. 1966).

In continuing studies of X-agent, said to be of cosmic origin, it was found during 1963 that the transmittance of bismuth oxychloride solutions was increased when placed outdoors or near a window in a room. This increase of transmittance became barely observable in 1964, and during 1965 the transmittance was decreased by such exposure, in contrast to the earlier observations of an increase. Such a reversal was no longer obtained at the end of 1965, and from then until the present (July, 1966) the transmittance again increased when solutions were placed outdoors. Detailed data are presented concerning these findings. It is suggested that this phenomenon is the result of marked alterations taking place during 1964 and 1965 in the soft component of the X-agent. Similar marked alterations were found at almost the same time with neutral-red solutions. Thus, the greatest change seemed to occur in the X-agent in its action on neutral-red solutions during 1964 and 1965. The change was especially manifested during 1965; then, there was a long period from June to October when the pigment solutions, if placed inside a dark room or a metal box, where very soft components of the agent could not reach them, were scarcely affected. (BBB)

13412 CENTRAL COLLISIONS OF COSMIC NUCLEI WITH EMULSION HEAVY NUCLEI. Babayan, Kh. P.; Marutyan, N. A. (Inst. of Physics, State Atomic Energy Commission, USSR). Dokl. Akad. Nauk Arm. SSR, 42: 97-100(1966). (In Russian).

The usual interpretation of central interactions of multiply-charged energetic cosmic-ray particles with the emulsion of the photoemulsion, based on the absence of fragments with a $Z \geq 2$ of the incident nucleus among the secondary relativistic particles is not quite satisfactory; it may be assumed that not all of the nuclei participate in the reaction or that other mechanisms intervene in it. Therefore, multiple interactions, with $n_s \geq 100$, in which all incident nuclei participate, were examined. The emulsion was exposed to the radiation in an earth satellite, determining the energy of the particles in the center-of-mass system by the method developed by C. Castagnoli et al.; the energy of the secondary particles was estimated from the geometry of the tracks obtained under consideration of multiple scattering. It was not possible to conclude from the results that nucleus-nucleus interactions differ from individual nucleon-nucleus superpositions. (TTT)

Direct Energy Conversion

13413 (AD–639994) INVESTIGATION OF THE CURRENT DENSITY LIMITATIONS IN A THERMIONIC CONVERTER. Final Report, January 1–July 15, 1965. Kaplan, Coleman (Marquardt Corp., Van Nuys, Calif.). Aug. 1966. Contract Nonr-3738(00). 42p. CFSTI $3.00 cy, $0.65 mn.

Transient measurements were made in a thermionic converter to investigate the ion loss mechanism at various operating conditions. A small pulsed increase in current was applied to the converter; just after the pulse an increase in output voltage was observed. The increased voltage then decayed back to the steady-state level. The time constant of the exponential voltage decay is a measure of the average lifetime of ions in the interelectrode space. The previous pulsed-discharge measurements are extended to larger spacings and higher xenon pressures. At large electrode spacings the primary ion loss mechanism is volume recombination; at small spacings (20 mils or less) the ions are lost by diffusion to the electrodes, where surface recombination occurs. The volume-recombination lifetime decreases with increasing cesium and/or xenon pressure. The output voltage was measured for a range of spacings extending to over 200 mils, at

each value of the current, cesium pressure, and xenon pressure used. It was observed that, at constant current, the output voltage is a linearly decreasing function of the spacing, for spacings of the order of 100 mils or larger. The decrease in the output voltage with increasing spacing is apparently due to a corresponding increase in the emitter sheath potential. This linear characteristic could prove useful in an analysis of converter theory. (auth)

13414 (N-66-39333) SIMPLIFIED MODEL OF SEGMENTED ELECTRODE LOSSES IN NONEQUILIBRIUM MHD GENERATORS. Hoffman, Myron A. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Aug. 1966. 31p. (NASA-CR-78750). CFSTI $3,00 cy, $0,65 mn.

Linear, segmented-electrode MHD generators designed to utilize nonequilibrium ionization have not yet produced the expected performance. Kerrebrock proposed that this could be due to shorting of the Hall current along the electrode wall. A simplified two-layer model of these important generator nonuniformities is proposed. Solutions of the resulting set of algebraic equations exhibit the same essential behavior as Kerrebrock's more complete theoretical formulation. In particular, the equations yield the "normal" and the "shorted" modes found by Kerrebrock and permit the calculation of the stability boundary between these modes. (auth)

Fluid Physics

13415 (AD-639343) DISCONTINUITIES IN NON-IDEAL MAGNETOGASDYNAMICS. Friedel, H. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). June 27, 1966. Contract AF 61(052)-675. 18p. (AFOSR-66-1862). CFSTI $3,00 cy, $0,65 mn.

The well known evolutionary condition of ideal MGD is extended to nonideal, one-dimensional MGD characterized by arbitrary dissipation terms. It is shown that in this case discontinuities may exist fulfilling the evolutionary condition. Concluding the case of a dissipation term due to finite electrical conductivity and its effect on contact discontinuities is investigated. These discontinuities are found to be non-evolutionary and therefore physically meaningless. (auth)

13416 (AD-639754) MHD GENERATOR AND ACCELERATOR EXPERIMENTS IN SEEDED AND UNSEEDED AIR FLOWS. Technical Information Series. Harris, Clarence J.; Marston, Charles H.; Warren, Walter R. Jr. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Sept. 1966. Contracts AF 04(647)-269; AF 40(600)-1091. 29p. (R-66SD50). CFSTI $3,00 cy, $0,65 mn.

Two types of MHD experiments were conducted using air flows produced by hypersonic shock tunnels. One experimental program was designed to evaluate the feasibility of using the Lorentz forces developed in an MHD generator for the attitude control of a hypervelocity vehicle. During this study the electrical conductivity of the seeded shock layer flow about a blunt model located in the shock tunnel test section was investigated along with the effect of pre-heating the generator electrodes. In the second experimental program, a Faraday accelerator is being studied to determine its ability to add kinetic energy to a high-density, unseeded air flow in a high-enthalpy shock tunnel. Measurements were made of the gross electrical conductivity of the flow, with and without an applied magnetic field. The meaning of the electrical conductivity measurements for each of these experiments is discussed. (auth)

13417 (AFOSR-67-0004) FLAT-PLATE MAGNETOHYDRODYNAMIC BOUNDARY LAYER IN A TRANSVERSE MAGNETIC FIELD. UTIAS Technical Note No. 68. Dukowicz, J. K. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Jan. 1967. 19p.

The equations of motion for a flat-plate boundary layer flow of an incompressible, electrically conducting fluid in the presence of a transverse magnetic field moving with the main stream velocity have been solved numerically for the case of negligible induced magnetic field. The equations of motion have been transformed into a universal form with no characteristic parameters present. The velocity profiles have been calculated as the range from the Blasius profile to the asymptotic exponential profile. The asymptotic profile is reached in a distance $x_1 \simeq \rho U_\infty / \sigma B^2$ from the leading edge. The error due to the finite-difference solution has also been calculated. (auth)

13418 (LA-3629) 2DE: A TWO-DIMENSIONAL EULERIAN HYDRODYNAMIC CODE FOR COMPUTING ONE COMPONENT REACTIVE HYDRODYNAMIC PROBLEMS. Gage, William R.; Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Oct. 1966. Contract W-7405-eng-36. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A description is given of a code for the IBM 7030 computer for computing two-dimensional reactive hydrodynamic problems in cylindrical geometry using a modification of Gentry's finite difference analogs of the Eulerian equations of motion for a compressible fluid. (auth)

13419 (STI-PUB-128(Vol.1)) ELECTRICITY FROM MHD. VOL. I. Proceedings Series. Proceedings of a Symposium Held in Salzburg 4-8 July 1966. (International Atomic Energy Agency, Vienna (Austria)). Oct. 1966. 712p. (CONF-660704-(Vol.1)). IAEA: $15.00; S 388,-; £5.5.10; F Fr 73,50; DM 60,-.

The proceedings show the substantial progress made in MHD generator development, in particular the advances in high-temperature materials, the development of large, high-intensity, superconducting magnets, and the improved understanding of the detailed behavior of such systems under various operating conditions. This volume (I) contains papers on general physical problems related to MHD; such as diagnostics, shock tubes, flow and field distribution, and auxiliary ionization and relaxation. Separate abstracts were prepared for the papers and they appeared in NSA Vol. 20 numbers 21 and 22. Volumes II and III are in preparation. (W.D.M.)

13420 CONSERVATION LAW IN THE MAGNETOHYDRODYNAMICS OF AN IDEAL CONDUCTING LIQUID. Sexl, Theoder (Univ., Vienna). Acta Phys. Austr., 24: 120-8(1966). (In German).

In the expansion of a previously published study the conservation law in magnetohydrodynamics of an ideal conducting liquid was investigated and it was shown that the magnetohydrodynamics from the theory of the ideal liquid causes the voltage diad Π_{magn} of the Maxwell electrodynamics to be additively superimposed over the voltage diad of the ideal liquid $\Pi = -\underline{p}E$. (tr-auth)

13421 CIRCULATORY FLOW OF A CONDUCTING LIQUID ABOUT A POROUS, ROTATING CYLINDER IN A RADIAL MAGNETIC FIELD. Gupta, A. S. (Indian Inst. of Tech., Kharagpur, India). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 380-2 (Feb. 1967).

If an infinite circular cylinder immersed in a viscous liquid at rest is suddenly rotated about its axis, the vortex sheet that is initially concentrated on the surface of the cylinder diffuses outwards due to viscosity until vorticity vanishes everywhere. If suction is applied through the cylinder surface, the vorticity will ultimately settle to a steady-state distribution in which the outward diffusion is balanced by the convection of vorticity towards the cylinder. Exact solution for such a steady state has been given by Preston. The steady-state problem considered by Preston is extended to the case of an electrically conducting liquid in the presence of a radial magnetic field. (J.H.M.)

13422 HEAT TRANSFER IN RELATIVISTIC CHARGED-FLUID FLOW. Schmid, L. A. (Goddard Space Flight Center, Greenbelt, Md.). Nuovo Cimento (10), 47B: 1-28(Jan. 11, 1967).

The problem of the dynamical effects of heat absorption or rejection on the flow of an electrically charged fluid such as an electron or ion gas is considered within the framework of special relativity. The source or sink for the heat transferred to or from the fluid may be imagined to be a heat reservoir whose velocity is in general not the same as the fluid velocity. The analysis of a relativistic Carnot cycle that operates between two heat reservoirs having relative motion with respect to each other provides a simple way to study the dynamical effects of heat transfer and to incorporate the moving heat reservoir model into the formalism of fluid dynamics. All the dynamical effects that are functions of the 4-gradient of the specific entropy of the fluid can be expressed in terms of an antisymmetric tensor, the entropy-force tensor, whose role in the equation of fluid motion is analogous to that of the electromagnetic field tensor. (auth)

13423 HYDROMAGNETIC WAKE AROUND A NONCONDUCTING SPHERE. Chow, Chuen-yen (Univ. of Notre Dame, Ind.). Phys. Fluids, 10: 234-6(Jan. 1967).

Flow around a nonconducting sphere moving slowly through a current-carrying fluid along an arbitrary direction is considered. Standing eddies are found under certain conditions and a wake ahead of the sphere is possible. (auth)

13424 FREE-CONVECTION MAGNETOHYDRODYNAMIC ELASTICO-VISCOUS FLOW PAST A POROUS PLATE. Mishra, Shankar Prasad (Univ. Coll. of Engineering, Burla, India). Indian J. Pure Appl. Phys., 4: 443-6(Dec. 1966).

The problem of free convection magnetohydrodynamic elastico-viscous flow past a porous flat plate, when a body force g per unit mass is acting in the negative x direction parallel to the wall, was investigated and graphs showing the effect of free convection, magnetic field, and elasticity of the liquid on the fluid velocity were obtained. The skin friction at the plate is affected by free

convection and the Prandtl number, but is independent of the magnetic field and the elasticity of the liquid. The velocity of the fluid increases with the Grashof number but decreases with increase in Prandtl number. In a thin liquid layer at the plate, the fluid velocity decreases with the increase of applied magnetic field strength, but outside this layer it increases. (auth)

13425 INFLUENCE OF A MAGNETIC FIELD ON VISCOUS GAS FLOW. Kikoin, I. K.; Balashov, K. I.; Lasarev, S. D.; Neushtadt, R. E. (Kurchatov Inst. Atomic Energy, Moscow). Phys. Lett., 24A: 165-6(Jan. 30, 1967).

Effects of gases flowing in a magnetic field analogous to the Hall effect and planar Hall effect in conductors are investigated. It is shown that for oxygen those effects are not functions of H/P only, that is in contradiction with the existing theory. (auth)

Geophysics

Refer also to abstract 13344.

13426 (AD-640407) LABORATORY MODELING OF THE SOLAR WIND. Interim Scientific Report. Patrick, R. M.; Pugh, E. R. (Avco-Everett Research Lab., Everett, Mass.). Aug. 1966. Contract AF 49(638)-1483. 17p. (AMP-204; AFOSR-66-2055). CFSTI $3.00 cy, $0.65 mn.

The IMP satellite measurement and a theoretical study indicate that the solar wind interaction with the earth's B field has properties similar to a continuum flow. A laboratory facility was built, which simulates this flow, and produces a steady flow of collisionless plasma with a large diameter compared to the ion gyro radii. A description of this facility, the design criteria and some results of flow studies are given. (auth)

13427 (N-66-24642) ROCKET MEASUREMENTS OF ENERGETIC ELECTRON PRECIPITATION IN THE AURORAL ZONE. Evans, David S. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1966. 33p. (NASA-TM-X-55447; X-611-66-9). CFSTI $3.00 cy, $0.65 mn.

Direct measurements were made of the auroral electron influx in the energy range 2 to 6 keV by particle detectors carried through a diffuse, post-breakup auroral display aboard a rocket launched from Fort Churchill in March, 1965. This display was accompanied by both ionospheric absorption of cosmic radio noise and by very strong geomagnetic activity. Electron intensities averaging 3×10^8 electrons ($E > 25$ keV) cm^2/sec/sterad and exceeding at times $10^9/cm^2$/sec/sterad were encountered during the flight. The electron energy spectra were quite flat, generally being characterized by e-folding energy between 20 and 35 keV but reaching 50 keV at one time. Both the electron flux and the energy spectra exhibited rapid (~0.5-sec) variations on occasion during the flight. The association of the post-breakup aurora, ionospheric absorption, and geomagnetic activity with the observation of large fluxes of precipitated electrons of energies greater than 25 keV form a picture consistent with an intense auroral zone x-ray event. In addition, the overall character of the electron precipitation sampled by this rocket suggests a close association with those electron streams observed by McDiarmid and Burrows on Allouette. (auth)

13428 (N-66-32764) APPENDIX: SOME SPECTROSCOPIC OBSERVATIONS OF THE INTERACTION BETWEEN A PLASMA WIND AND A DIPOLE MAGNETIC FIELD. Nilson, J. A.; Crane, R. A. (RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.). Feb. 1966. Contract NASw-1088. 20p. (NASA-CR-76879). CFSTI $3.00 cy, $0.65 mn.

Simulated solar wind-magnetosphere turbulences were studied spectroscopically and by automatic photography through seeded plasma interactions with magnetic dipole fields. The integrated photographs of the produced bright crescent-shaped region of luminosity—apparent only for a few tens of microseconds—showed a form similar to that of Van Allen belts. To the left of this phenomenon was the stand-off boundary region where the pressure of the plasma equaled the magnetic pressure. In some photographs a polar blob was observed above the windward of the poles that was not visible in the spectra. (STAR)

13429 (N-66-37209) MODEL RING CURRENT BELTS. Akasofu, S.-I. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). July 1966. 63p. (NASA-CR-78122). CFSTI $3.00 cy, $0.65 mn.

Some numerical results of an extensive calculation of model storm-time radiation belts or the so-called ring current belts are tabulated. The models are constructed by choosing most plausible sets of the six parameters that characterize the belts. (STAR)

13430 (N-66-37210) EXPLORER 12 OBSERVATIONS OF CHARGED PARTICLES IN THE INNER RADIATION ZONE. Ackerson, K. L.; Frank, L. A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). June 1966. Contract Nonr-1509(06). 46p. (NASA-CR-78123). CFSTI $3.00 cy, $0.65 mn.

Measurements of energetic charged particles in the inner radiation zone with two shielded, omnidirectional Geiger-Mueller tubes flown on Explorer 12 were used to construct B-L contours of the omnidirectional intensities of protons $E_p > 21$ MeV and $E_p > 70$ MeV for the period August 16 to September 19, 1961, prior to the Starfish high-altitude nuclear burst on July 9, 1962. The values of proton ($E_p > 21$ MeV) omnidirectional intensities are in substantial agreement with the post-Starfish values from Telstar 2 and with other observations. Upper limits for the omnidirectional intensities of electrons $E_e > 1.6$ MeV at the geomagnetic equator before the Starfish test are also given. (auth)

13431 (N-66-39694) IONOSPHERIC ELECTRON DENSITY DURING SOLAR ECLIPSE OF JULY 20, 1963. Cornellier, J. R.; Pound, T. R. (Illinois Univ., Urbana. Electrical Engineering Research Lab.). 1966. 56p. (NASA-CR-78930). CFSTI $3.00 cy, $0.65 mn.

Data derived from ionograms obtained during the solar eclipse of July 1963, are discussed according to height intervals, since the range of the electron density profiles spanned the height intervals associated by convention with the E, F1, and F2 regions of the ionosphere. The similarities and dissimilarities in the observations at different ionosonde stations are noted, and probable causes of the observed behavior with reference to processes occurring in the ionosphere are investigated. The electron density continuity equation is reviewed and interpretation of the parameter S_{cat}, which is related to the thickness of the F2 peak, is discussed. (STAR)

13432 (N-66-39998) INVESTIGATION OF THE D AND E REGION DURING THE IQSY. Final Report, 1964-1965. Smith, L. G.; McKinnon, P. J.; Weeks, L. H. (Geophysics Corp. of America, Bedford, Mass.). May 1966. Contract NASw-1141. 120p. (NASA-CR-79096; GCR-TR-66-16-N). CFSTI $3.00 cy, $0.65 mn.

An investigation of the ionosphere up to about 180 km during the second year of the International Quiet Sun Year (1964 to 1965) is described. One series of rockets was launched on the NASA Mobile Launch Expedition in the South Pacific in a study of the latitude variation of the ionosphere. The other series of flights was made from Wallops Island in the study of seasonal variation. The last flight of this series was used to investigate the phenomenon of anomalous winter absorption. (auth)

13433 (UCID-15048) EXPLOSION OF A 500 MEGATON BOMB AT THE SURFACE OF THE EARTH; A NUMERICAL CALCULATION OF ATMOSPHERIC EFFECTS. Viecelli, James (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1966. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results from a numerical calculation of the atmospheric hydrodynamic effects of a 500-Megaton surface explosion are presented. (auth)

13434 DIURNAL CHANGES OF PHASE AND GROUP VELOCITY OF vlf RADIO WAVES. Westfall, W. D. (Navy Electronics Lab., San Diego, Calif.). Radio Sci., 2: 119-25(Jan. 1967).

Very-low-frequency radio-wave diurnal phase changes for frequencies between 10.2 and 26.1 kHz, inclusive, are tabulated and plotted as a function of frequency and path distance. Ninety measurements are listed, of which 25 are new data. By using a daytime theoretical phase velocity for a homogeneous, sharply bounded ionosphere at 70 km, which agrees well with experimental data, it is possible to obtain a nighttime first-order-mode phase-velocity curve that does not change with frequency in an easily predictable manner. First-order-mode phase velocity curves are used to obtain estimates of first-order-mode group velocity. These calculations suggest that for frequencies less than about 16 kHz the nighttime group velocity is greater than the daytime group velocity. Above 16 kHz it appears that the nighttime group velocity is less than the daytime group velocity. Calculated average group velocity is in agreement with a recent experimental measurement at 17.8 kHz within the experimental error. (auth)

13435 TIME DEPENDENCE OF THE LOW-ENERGY PROTON BELTS. White, R. Stephen (Aerospace Corp., El Segundo, Calif.). Contract AF 03(695)-669. J. Geophys. Res., 72: 943-50(Feb. 1, 1967).

The time dependences of the low-energy proton space distributions and differential energy distributions at 8 energies, 0.17 to 3.4 MeV, are presented for the period of August 15, 1964, to February 8, 1965. The data were obtained from the directional proton spectrometer on the satellite 1964-45A, which was launched on

August 14, 1964, into a near polar orbit with a 3765-km apogee and a 270-km perigee. The proton flux decay constant can be expressed as $(1/\tau)\ (\text{day})^{-1} = (-0.0007 \pm 0.0007) + (0.0033 \pm 0.0009)\ \ln_e E\ (\text{MeV})$. Protons of 0.2 MeV decreased with an apparent lifetime of 150 days, those of 1 MeV were constant, and protons of 2.5 MeV increased with an apparent lifetime of 500 days. The maximum peak heights of the energy distributions decreased by less than a factor of 2, and the energy spectra hardened slightly with time. The positions of the maxima remained almost constant. Therefore, the low-energy proton radiation belts were rather stable from August 15, 1964, to February 8, 1965. (auth)

13436 EXPLORER 12 OBSERVATIONS OF CHARGED PARTICLES IN THE INNER RADIATION ZONE. Ackerson, K. L.; Frank, L. A. (Univ. of Iowa, Iowa City). Contract Nonr 1509 (06). J. Geophys. Res., 72: 951-7(Feb. 1, 1967).

Observations of energetic charged particle intensities in the inner radiation zone with two shielded, omnidirectional Geiger–Müller tubes flown on Explorer 12 are used to construct B-L contours of the GM tube responses for the period August 16 to September 19, 1961, prior to the Starfish high-altitude nuclear burst on July 9, 1962. The energy thresholds for penetrating particles are $E_p = 21$ MeV and $E_e \simeq 1.6$ MeV for the 302 GM tube and $E_p = 65$ MeV and $E_e \simeq 20$ MeV for SPB, a heavily shielded background GM tube of an electron spectrometer. The character of these measurements does not allow a unique identification of the GM tube responses as attributable to penetrating protons or electrons, but comparison with other inner-zone proton observations strongly indicates that their responses are predominantly due to penetrating protons. These B-L contours are important in providing preStarfish responses of these GM tubes over a large region of the inner radiation zone for subsequent studies of the decay of the artificially injected radiation. Upper limits for the omnidirectional intensities of electrons $E_e \gtrsim 1.6$ MeV at the geomagnetic equator before the Starfish test are $J_0 \leq 10^4\ (\text{cm}^2\ \text{sec})^{-1}$ at L = 1.2, $\leq 4 \times 10^4\ (\text{cm}^2\ \text{sec})^{-1}$ at L = 1.25, $\leq 2.5 \times 10^5\ (\text{cm}^2\ \text{sec})^{-1}$ at L = 1.5, $\leq 8 \times 10^4\ (\text{cm}^2\ \text{sec})^{-1}$ at L = 1.8, and $\leq 1.5 \times 10^4\ (\text{cm}^2\ \text{sec})^{-1}$ at L = 2.4. (auth)

13437 COMPARISON OF THE LOW-ALTITUDE INNER-ZONE 55-MeV TRAPPED PROTON FLUXES MEASURED IN 1965 AND 1961–1962. Filz, Robert C. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 72: 959-63(Feb. 1, 1967).

Trapped proton (55 MeV) flux data obtained from nuclear photographic emulsions exposed in Air Force satellites in the 200- to 400-km altitude interval during 1965 are compared to data previously reported. No significant decay is detected since mid-1963, and in fact a slight increase is observed. During this period a decay of a factor of almost 2 is expected following the redistribution observed in July 1962 due to the high-altitude Starfish explosion. The 1965 absolute flux levels are found to be in reasonable agreement with those predicted by Blanchard and Hess on the basis of solar cycle atmospheric density variations and neutron albedo injection. The relative increase observed depends more on solar cycle atmospheric density changes than on the source mechanism as long as the source strength is of the magnitude used by Blanchard and Hess and reasonably constant. (auth)

13438 ADIABATIC MOTION OF ENERGETIC PARTICLES IN A MODEL MAGNETOSPHERE. Roederer, Juan G. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 981-92(Feb. 1, 1967).

The motion of charged particles in a model magnetosphere is studied using the three adiabatic invariants. The particle shell geometry is determined, and drift velocities, bounce periods, and equatorial pitch angles are computed as a function of local time. The following conclusions were reached: (1) Shell splitting in the outer magnetosphere becomes important beyond 5 R_E (earth radii). This means that particles mirroring at different points on the same field line at noon appear spread over a region of field lines at midnight, and vice versa. (2) There are regions in the magnetosphere, where only pseudo-trapped particles can mirror, i.e., particles that will leave the magnetosphere before completing a 180° drift. (3) Longitudinal drift velocities depart considerably from the dipole values beyond 5 R_E, and can be as much as 2 to 3 times greater on the night side than on the day side. Thus a given particle spends 2 to 3 times more time in the day side than in the night side. (4) After recovery from a prototype magnetic storm, particles that were in the day side during the sudden commencement will have higher energies, their shells having moved radially inward. Particles caught in the night side will have moved outward, with their energies decreased. (auth)

13439 PLASMA INSTABILITY ASSOCIATED WITH THERMAL ANISOTROPIES IN THE SOLAR WIND. Scarf, F. L. (TRW Systems, Redondo Beach, Calif.); Wolfe, J. H.; Silva, R. W. J. Geophys. Res., 72: 993-1005(Feb. 1, 1967).

Recent solar wind measurements on the Pioneer 6 spacecraft reveal that, in general, the proton velocity distribution is anisotropic with $T_{\|} > T_{\perp}$, where the subscripts refer to direction with respect to the interplanetary magnetic field. Production of the anisotropy by magnetic moment conservation is discussed, and the consequences of this particle distribution with respect to stability of the plasma are analyzed. It is shown that a generalized form of the firehose instability must occur, with growth of magnetosonic (whistler mode) waves near the ion cyclotron frequency. Growth rates are computed for a range of wave frequencies and distances from the sun, and these predictions are compared with available interplanetary power spectra. (auth)

13440 FIELD-ALIGNED CURRENTS IN THE MAGNETOSPHERE. Cummings, W. D.; Dessler, A. J. (Rice Univ., Houston, Tex.). Contract AF 19(628)-3858. J. Geophys. Res., 72: 1007-13(Feb. 1, 1967).

Certain satellite and terrestrial observations of transient magnetic fluctuations show a high degree of localization, while other observations are of a definite worldwide character. The worldwide fluctuations in the magnetic field are probably well explained in terms of hydromagnetic waves propagating through the magnetosphere in modes with the wave polarization current flowing perpendicular to the geomagnetic field. However, for the localized fluctuations such an interpretation is inconsistent with present theory of hydromagnetic wave propagation in the magnetosphere. We suggest that the observations of localized magnetic fluctuations might be better interpreted in terms of field-aligned currents in the magnetosphere. (auth)

13441 PROPAGATION OF ATMOSPHERIC GRAVITY WAVES THROUGH REGIONS OF WIND SHEAR. Hines, C. O.; Reddy, C. A. (Univ. of Chicago). J. Geophys. Res., 72: 1015-34(Feb. 1, 1967).

The propagation of atmospheric gravity waves to ionospheric heights from lower regions is complicated by the presence of background wind shears, which can act to remove a portion of any incident wave spectrum. An evaluation is made of the possible importance of such a removal process. The general problem of acoustic–gravity waves, propagating through regions of vertically varying background winds and temperatures, is investigated first. A multilayer approximation is adopted, and methods for evaluating the transmission of energy are established. Certain fundamental problems in the propagation of hydrodynamic energy are raised, but not pursued in depth. The importance of singular levels in the wind profile is reconfirmed, though with an emphasis on absorption rather than reflection at such levels. An unanticipated importance of temperature gradients is clarified in the course of the analysis. Calculated transmission coefficients are presented for three assumed atmospheric wind profiles, with and without temperature structure. The results indicate that the processes considered here will not severely attenuate a broad incident wave spectrum in the course of its upward passage through the mesosphere, though strong attenuation, particularly of modes with horizontal phase speeds $\lesssim 50$ m/sec, must be expected low in the thermosphere. Even when the overall attenuation is low, substantial directional filtering can occur such that the wave spectrum in ionospheric regions may exhibit marked azimuthal variations in response to the wind structure at underlying levels. It is suggested that this directional filtering can be a major cause of the seasonal and diurnal variations that occur in measured ionospheric drifts. (auth)

13442 SPATIAL VARIATIONS OF IONOSPHERIC HEIGHT AT MIDDLE LATITUDES. Ross, W. J.; Kuntman, D. (Pennsylvania State Univ., University Park). J. Geophys. Res., 72: 1041-6 (Feb. 1, 1967).

A method is developed for the determination of mean ionospheric height from an analysis of radio signals from a beacon satellite. Simultaneous measurements of Faraday rotation and Doppler dispersion are combined, and their mutual consistency is coupled with the height dependence of the earth's magnetic field to calculate mean ionospheric height along the locus of satellite directions from the observing station. The method is applied to a number of satellite passes involving both normal and unusual ionospheric conditions, and profiles of height are developed over a working range of about 5° of latitude. Spatial variations of height of up to 50 km within this range are found. (auth)

13443 SPATIAL RELATIONSHIP OF AURORAL OI AND N_2^+ EMISSIONS. Murcray, Wallace B. (Univ. of Alaska, College). J. Geophys. Res., 72: 1047-51(Feb. 1, 1967).

Rocket flights carrying photometers into luminous aurora show that N_2^+ and OI auroral light emissions have a different intensity distribution in the horizontal as well as the vertical direction, the OI emissions being considerably more restricted in horizontal area than the N_2^+. (auth)

13444 ELECTRON NUMBER DENSITIES IN AURORAL IRREGULARITIES: COMPARISON OF BACKSCATTER AND SATELLITE DATA. Lund, D. S. (Environmental Science Services Administration, Boulder, Colo.); Hunsucker, R. D.; Bates, H. F.; Murcray, W. B. J. Geophys. Res., 72: 1053-9(Feb. 1, 1967).

Explorer 20 topside sounder electron number density data are compared with simultaneous auroral backscatter data obtained at College, Alaska. The results show that auroral precipitation produces electron number-density fluctuations that are large in amplitude (of the order of 2× to 5× ambient) and small in geographic size (of order 1 to 10 km), along with a general increase in the ionospheric electron number density within the latitudinal region containing the precipitation. The increased electron number density appears to be the result of ionization (primary and secondary) produced by auroral particles within an altitude range of several hundred kilometers around the satellite. (auth)

13445 ION TEMPERATURES MEASURED AROUND A DAWN–DUSK AURORAL-ZONE SATELLITE ORBIT. Knudsen, William C.; Sharp, Gerald W. (Lockheed Research Lab., Palo Alto, Calif.). J. Geophys. Res., 72: 1061-72(Feb. 1, 1967).

Ion temperature has been derived from retarding potential analyzer data obtained around an orbit oriented such that the mid and low latitudes were traversed approximately at dawn and dusk and the auroral zones at noon and midnight. The altitude varied from 210 to 516 km. Ion temperature profiles exhibited good similarity from one orbit to the next but large changes occurred over periods of several orbits. Ion temperature profiles in the middle and low latitudes on the dusk side of the orbit exhibited peaks and troughs with trough values representative of expected neutral gas temperatures (900 to 1200°K) and peak values comparable to measured electron temperatures (2000 to 3000°K). Auroral-zone ion temperatures varied over periods of several orbits from 2000 to over 6000°K. The variation suggests a universal time control. Unexpected high ion temperatures are unlikely to be the result of instrument effects but could be unreal if properly directed ion drift velocities comparable to the satellite velocity were present. (auth)

13446 MESOSPHERIC ELECTRON NUMBER DENSITIES AT 35°S LATITUDE. Gregory, J. B.; Manson, A. H. (Univ. of Saskatchewan, Saskatoon, Can.). J. Geophys. Res., 72: 1073-80 (Feb. 1, 1967).

The mean noon profile of mesospheric electron number density has been obtained at a location of 35°S, 173°E for the week preceding the total solar eclipse of May 31, 1965, and immediately after the eclipse. Values of electron number density increased monotonically, within the experimental errors of the order of 50%, from 85/cm^3 at 70 km to 1200/cm^3 at 90 km. Diurnal variations of nonsolar origin were detected, possibly owing to a pressure fluctuation. Data obtained by the radio-wave differential absorption technique using partial reflections were compared with data obtained by Faraday rotation techniques from a series of rocket firings conducted by National Aeronautics and Space Administration. The results obtained by the two techniques were in satisfactory agreement. (auth)

13447 ENERGETIC TRAPPED ELECTRON OBSERVATIONS DURING THE FALL OF 1964. Mihalov, J. D. (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-669. J. Geophys. Res., 72: 1081-94(Feb. 1, 1967).

Data from a directional electron spectrometer on satellite 1964–45A, taken during late August, 1964, are presented on B–L plots for seven differential energy channels ranging from 0.26 to 3.6 MeV. The satellite was launched on August 14, 1964, into a near-polar orbit with a 3765-km apogee and a 270-km perigee. Outer-zone electron fluxes during the geomagnetically quiet times of August 15–28 are returning to equilibrium after the sudden commencement geomagnetic storm of August 11. Significant losses of electrons at a much greater rate are observed twice. During late August and November–December 1964, the location of peak electron fluxes of various energies in the outer zone resembles solutions of an equation derived by Tverskoy who assumed that inward diffusion is the electrons' source. The limited inner-zone directional electron data are compared with 1962 results of West et al. A large decrease of inner-zone 0.3-MeV electron fluxes since 1962 at B ~ 0.17 to 0.2 gauss implies these soft electrons observed in 1962 were injected by the July 9, 1962, high-altitude nuclear test. Theoretical estimates of the electron flux expected from decay of neutrons from this source are < 15% of those measured in 1962. (auth)

13448 ELECTRIC FIELD MEASUREMENTS IN THE AURORAL IONOSPHERE. Mozer, F. S. (Univ. of California, Berkeley); Bruston, P. J. Geophys. Res., 72: 1109-14(Feb. 1, 1967).

Vector electric field and particle intensity measurements were made on a sounding rocket launched into a visible aurora near local midnight. Preliminary results of the dc electric field measurement indicate that electric fields as large as 85 millivolts/meter were observed, that the component of the electric field in the plane perpendicular to the magnetic field direction pointed generally equatorward, and that the component of the dc electric field along the magnetic field direction had a magnitude as large as 20 millivolts/meter. (auth)

13449 DAYSIDE MAGNETIC DISTURBANCES AT 1100 KILOMETERS IN THE AURORAL OVAL. Zmuda, A. J.; Heuring, F. T.; Martin, J. H. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 72: 1115-17(Feb. 1, 1967).

Data are presented on dayside magnetic disturbances obtained with satellite 1963 38C launched on September 28, 1963, into a nearly circular polar orbit with altitude about 1100 km. Information is included on the dayside variation of the southern and northern boundaries of the auroral oval and the distribution of oval widths and disturbance amplitudes. (J.H.M.)

13450 ROCKET MEASUREMENTS OF D-REGION ELECTRON NUMBER DENSITIES AT SUNRISE. Kane, J. A. (Goddard Space Flight Center, Greenbelt, Md.); Troim, J. J. Geophys. Res., 72: 1118-20(Feb. 1, 1967).

A sample of a telemetry record showing primary data of a Faraday rotation experiment is given. The 2.4-Mc plane of polarization angle versus rocket altitude and the results from three rocket firings at solar zenith angles of 95, 84, and 74° are shown. The electron density results for 35°S latitude are plotted as a function of zenith angle together with ground-based results obtained at 35°N latitude using the partial reflection method. There is a tendency for the electron number density isopleths to follow the contours of constant Lyman alpha flux. This flux is presumed to be the flux that ionizes the quiet D region. (J.H.M.)

13451 OBSERVATIONS OF THE EARTH'S MAGNETIC TAIL AND NEUTRAL SHEET AT 510,000 KILOMETERS BY EXPLORER 33. Ness, N. F.; Behannon, K. W.; Cantarano, S. C.; Scearce, C. S. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 927-33(Feb. 1, 1967).

Direct measurements of the earth's magnetic tail at distances beyond the lunar orbit were performed by a magnetometer carried on the Explorer 33 satellite. The general characteristics of the tail and imbedded neutral sheet are observed to be similar to those reported earlier by IMP 1 at half the lunar distance. Field magnitudes of 10 to 18 gammas are found, and the field direction closely parallels the earth–sun line. These results indicate that once each lunar orbit the moon is immersed within the geomagnetic tail for periods up to 4 days. Also the moon may frequently be located within the neutral sheet during these intervals. A preliminary report of data obtained in July–August, 1966, is presented. (auth)

13452 SECONDARY IRREGULARITIES IN THE EQUATORIAL ELECTROJET. Cohen, Robert; Bowles, Kenneth L. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 72: 885-94(Feb. 1, 1967).

Although the two-stream instability theory, discussed by Farley, has been quite successful in accounting for many observed features of the plasma-wave irregularities produced in the equatorial electrojet, increased equipmental sensitivity and improved experimental techniques of observing the power spectrum of radio echoes from the electrojet have resulted in the resolution of weaker irregularities not predicted by that theory. In particular, such irregularities are observed both when a vhf radar located near the magnetic equator is directed vertically and when the radar is directed obliquely in the equatorial plane. In the latter case, the irregularities have lower Doppler shifts than are suggested by the theory. Experimental spectra are presented that demonstrate features consistent with the first-order two-stream theory for observations of a well-developed electrojet at oblique angles of incidence. However, the relative contribution of the weaker irregularities can be resolved in spectra for incidence angles approaching the zenith or, when the electrojet is comparatively weak, at most angles. The spectral width obtained at vertical incidence is shown to be narrow for a weak electrojet and to be broadened as the electrojet becomes stronger. The weaker irregularities probably result from the nonlinear interaction among the stronger irregularities, as is demonstrated by Dougherty and Farley. Experimental results are presented that indicate an asymmetry not predicted by either theory; i.e., the upward irregularities (observed at angles of incidence west of the zenith) are stronger than the downward irregularities (observed at angles of incidence east of the zenith). This asymmetry may be accounted for by the variation with height of the physical properties of the region of instability. (auth)

13453 IONOSPHERIC E-REGION IRREGULARITIES PRODUCED BY NONLINEAR COUPLING OF UNSTABLE PLASMA

WAVES. Dougherty, J. P. (Cambridge Univ., Eng.); Farley, D. T. J. Geophys. Res., 72: 895-901(Feb. 1, 1967).

The irregularities responsible for the strongest vhf echoes from the equatorial E region and the aurora appear to have been adequately explained as arising from a form of two-stream plasma instability. Many of the weaker features of the echoes from the electrojet irregularities cannot be explained on this basis, however. The waves generated by the instability will grow in amplitude until they are limited by nonlinear effects. These effects, furthermore, will cause coupling between waves that will generate new waves that cannot be directly excited. It is shown that scattering from such secondary irregularities can account for many of the weak features of the vhf echoes. The theory is only qualitative, but the agreement between its predictions and most of the experimental observations is quite good. (auth)

13454 UNSTABLE GROWTH OF UNDUCTED WHISTLERS PROPAGATING AT AN ANGLE TO THE GEOMAGNETIC FIELD. Kennel, C. F.; Thorne, R. M. (Avco-Everett Research Lab., Everett, Mass.). Contracts Nonr 2524(00); NASw-837. J. Geophys. Res., 72: 871-8(Feb. 1, 1967).

The local growth rate for whistler waves propagating at an angle to the geomagnetic field is combined with model ray path calculations to estimate the wave growth along the whistler path. This growth rate depends critically upon the equatorial plane distribution of electrons in the few hundreds of electron volt energy range. When the electron energy spectrum between 10^2 and $\sim 10^4$ keV is sufficiently hard, $\sim 1/E^2$, there exists a narrow region, $|\lambda| \sim 15°$, of whistler growth near the equatorial plane sufficient to make a whistler mode unstable over-all as it bounces back and forth across the equatorial plane between reflection points. The region of cyclotron growth shrinks for softer energy spectra. Only unducted whistlers generated by resonant particle instabilities are treated. (auth)

13455 QUASI-TRAPPED VLF PROPAGATION IN THE OUTER MAGNETOSPHERE. Thorne, R. M.; Kennel, C. F. (Avco-Everett Research Lab., Everett, Mass.). Contracts NASw-837; AF 49(638)-1483. J. Geophys. Res., 72: 857-70(Feb. 1, 1967).

Very low frequency radiation has now been detected in various regions of the magnetosphere, and it seems feasible in the near future to undertake experiments correlating the intensity of such radiation at different points along the ray path. The further suggestion that trapped electrons may generate whistler mode waves in equatorial high L regions has stimulated interest in the propagation of such waves in an unducted magnetosphere. A simplified but not unreasonable density distribution, proportional to magnetic field strength along the equator and constant along field lines, was used. For frequencies well below the electron cyclotron frequency and propagation vectors not too close to perpendicular to the magnetic field, this leads to an index of refraction relation independent of wave frequency and L, thus greatly simplifying the process of ray tracing. Waves originating at the equator rapidly become almost perpendicular to the field. Rough consideration of propagation in the neighborhood of the lower hybrid resonance suggests that low-frequency waves will be reflected before reaching the ionosphere and thus be quasi-trapped in the magnetosphere. Such waves would not be observed by low-altitude satellites. Waves of sufficiently high frequency should be detectable at low-altitudes but would then have wave vectors predominantly perpendicular to the ambient magnetic field and thus considerable energy in the oscillating electric field. (auth)

13456 APPLICATIONS OF A NEW TECHNIQUE FOR THE DETECTION OF ABSORPTION EVENTS USING A RIOMETER. Chivers, H. J. A.; Prescott, M. P. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 72: 1121-3(Feb. 1, 1967).

A simple development in the analog recording of the riometer output that makes possible the immediate recognition and measurement of ionospheric absorption events is reported. A sideral record taken with the riometer installation at Anchorage, Alaska, for January 1966 is shown. Also included is a collection of 10 quiet-day curves taken at Anchorage at 30 Mc between February and November, 1965. The spread of the curves varies from 0.5 to 0.3 db. (J.H.M.)

13457 CALCULATION OF THE VIRTUAL HEIGHT AND ABSORPTION OF RADIO WAVES IN THE IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zealand). Radio Sci., 2: 133-8(Feb. 1967).

Calculations for the ordinary ray under different conditions show that the effect of collisions can considerably reduce the virtual heights given by ray theory. This reduction is, however, caused entirely by the errors inherent in ray theory. Phase integral calculations show that the simplest ray theory result, ignoring collisions, is accurate to within 0.1% except under those conditions which require a full wave treatment. Calculations of absorption by integrating the absorption coefficient k up to the level X = 1 also give incorrect results, because of ray theory limitations. These errors are exactly counterbalanced by the errors in a commonly used approximation for k. The use of this approximation therefore gives results which are more accurate, by several orders of magnitude, than the use of the exact expression. (auth)

13458 VLF TRANSMISSION LOSS CALCULATED FROM SPECTRAL ANALYSES OF ATMOSPHERICS. Taylor, W. L. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 139-45(Feb. 1967).

VLF atmospheric data recorded during four 6-hr periods were analyzed to evaluate the feasibility of employing a new technique to determine attenuation rates over a particular path. The technique involves recording the spectral components of atmospherics arriving from within an adjustable azimuthal direction. Changes in transmission loss, deduced from the observed spectra, between day and night conditions for an approximate 3000-km path indicate differences in total transmission loss of about 15 db at 5 kHz, 1 or 2 db at 10 kHz and 40 kHz, and a negative loss, or gain, between 12 kHz and 30 kHz. (auth)

13459 OXYGEN SPECTRA IN DAYGLOW, TWILIGHT, AND DURING AN ECLIPSE. Noxon, J. F. (Harvard Univ., Cambridge, Mass.). Nature, 213: 350-3(Jan. 28, 1967).

There is evidence for a morning–evening asymmetry for the 1.27 μ O_2 band in twilight, and the evening decay appears slower at high latitude. No appreciable variation in the dayglow intensity was observed with latitude; the decreased dayglow intensity during an eclipse seems consistent with the theory involving production of $O_2(^1\Delta g)$ by photodissociation of ozone. (auth)

13460 OBLIQUE SWEEP-FREQUENCY EXPERIMENTS OVER A 2000-km NORTH–SOUTH SUBAURORAL PATH. Moeller, Hans G. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). Radio Sci., 2: 77-86(Jan. 1967).

The high-frequency limits for radio transmission are calculated from the data of vertical sounding stations. For distances <2000 km, only the vertical data of the station at the midpoint of the path are used. To check this rule, oblique and vertical sweep-frequency records observed under normal and anomalous conditions were compared. If the distribution of ionization is nearly constant along the route, normal conditions are present, and the high-frequency limits calculated from the midpoint station are consistent with the oblique observations. Anomalous conditions are present during winter nights. At this time the critical frequencies may vary over a distance of 500 km by a factor of 2 or more. These steep gradients imply that the maximum observed frequency is much higher than the calculated maximum usable frequency. Additional transmission modes are observed, which are explained using rough models. The steep gradients were found to be moving southward during the night. A statistical analysis indicates that the magnitude of the gradient and the extent of this motion is increased with increased magnetic activity. (auth)

13461 DETECTION OF SOLAR FLARE EFFECT DURING SEVERE GEOMAGNETIC DISTURBANCE FROM IONOSPHERIC FLARE EFFECTS. Deshpande, S. B. (Government Polytechnic, Khamgaon, India). Indian J. Pure Appl. Phys., 4: 483-4(Dec. 1966).

The solar flare effects or crochet type disturbances that occur concurrently with certain flares cannot be detected by geomagnetic methods when more severe types of geomagnetic effects are prevailing. The possibility of detecting solar flare effects in these cases from a combined study of the simultaneous records of magnetograms and the ionospheric flare effects is discussed. It is concluded that the existence of a solar flare effect can be inferred if a sharp rise in the horizontal force magnetogram is observed immediately following the beginning of sudden ionospheric disturbance effects, especially when the flare occurs during the main phase of the magnetic storm. (auth)

13462 EVIDENCE OF THE NIGHTTIME CURRENT REVERSAL IN THE EQUATORIAL ELECTROJET. Balsley, Ben B. (Inst. for Telecommunication Science and Aeronomy, Boulder, Colo.). Ann. Geophys., 22: 460-2(July-Sept. 1966).

Radar observations of the irregularities imbedded in the equatorial electrojet indicate that the westward traveling stream of electrons that exists during daylight hours may be shown to reverse direction during nighttime periods if the reasonable assumption is made that the velocity vectors of the plane waves by which the radar echoes are returned are in the general direction of the current flow. The data presented consist of the power spectra of echoes returned from the region of the equatorial electrojet at a frequency of 49.920 Mc. The strength of these vhf echoes returned from the region of the electrojet is well correlated with the current density of the electrojet during local daylight periods. The

data were obtained at the Jicamarca Radio Observatory located near Lima, Peru during March, 1965. The power spectrum of the echoing region observed during a nighttime period showed the echoing spectrum to be displaced from the transmitted frequency. This shift was in the positive direction, which would imply that the echoing centers were moving in a general direction toward the east. This feature of the nighttime electrojet region was apparent on the data taken during 2 nights of observations, but separated by 8 days. These data were taken during a magnetically quiet period and in the presence of some activity. (BBB)

13463 VARIATION OF THE MAGNETIC HORIZONTAL COMPONENT IN EASTERN AFRICA. Hunter, A. N.; Osborne, D. G.; Gouin, P.; Desai, R. (Univ. Coll., Nairobi, Kenya). Ann. Geophys., 22: 463-70(July-Sept. 1966).

The hourly variation of the horizontal (H) ionosphere component at Addis Ababa and Nairobi was compared by month and by season on international quiet and disturbed days for the period February, 1964, to January, 1965, inclusive. The magnitude of the diurnal range of H was similar at both stations although Addis Ababa is under the electrojet and the other remote from jet influence. The hourly variation in H is defined as the departure of the hourly value of H from the mean midnight value for the day (the mean midnight value being taken as the mean of the values for the hours 01 and 24 respectively for the same day). The Nairobi curves showed a steady rise from midnight to midday but the Addis Ababa curves showed a decrease from midnight to a morning minimum. Little correlation was found between the jet strength and the rest of the Sq current system. The current system in Eastern Africa merits further study and one method is to investigate the correlation of the magnetic elements for these 2 stations at different times of the day. (BBB)

13464 MAGNETIC STORM ENHANCEMENT OF THE 5577 A (OI) AIRGLOW EMISSION INTENSITY. Silverman, S. M. (Air Force Cambridge Research Labs., Bedford, Mass.); Bellew, W. Ann. Geophys., 22: 458-9(July-Sept. 1966).

The appearance of aurora in the polar cap coinciding with the sudden commencements of magnetic storms (SSC) was previously noted, and a search revealed a magnetic storm effect in the 5577 Å (OI) intensities as measured at both Haute Provence and Tamanrasset. The results are presented of data from Sacramento Peak, New Mexico, U. S. A. (geographic coordinates: Sacramento Peak, 32° 43′ N, 105° 45′ W; Tonantzintla, Mexico, 19° 02′ N, 98° 18′ W; Huancayo, Peru, 12° 02′ S, 75° 20′ W). The effect was small in magnitude and the results are therefore treated with caution; nevertheless, confirmation of the effect using data from widely separated stations with different types of equipment appeared of interest. For Sacramento Peak 32 cases suitable for analysis for the period 1956 to 1963 were found; for Tonantzintla 13 cases and for Huancayo 6 cases were found. The intensity for the time closest to the SSC was taken as Q_0 and the logarithms of the ratios of the intensities at other times to Q_0 were calculated. The dalay time of the maximum following the SSC is ~1 hr for Sacramento Peak, 1.5 hr for Tonantzintla, and 0.5 hr for Huancayo. These are comparable to the delay times at Haute Provence and Tamanrasset of ¾ and 1 hr, respectively. The fractional increase of intensity, measured from the SSC, is about 5% for Sacramento Peak, Tonantzintla, and Huancayo, which may be compared with an 8% and 10% increase at Haute Provence and Tamanrasset, respectively. The increases for all the stations are thus seen to be of the same order of magnitude. The intensity rise begins prior to the SSC, with the time from the beginning of the intensity rise to the SSC being about 1.5 hr for Sacramento Peak and 1 hr for the other 2 stations. There is an indication that the rise is itself preceded by a period of falling intensity, occurring several hours before the SSC. (BBB)

13465 EFFECTS OF A SOLAR ECLIPSE ON THE EQUATORIAL GEOMAGNETIC FIELD. Matsushita, S. (Univ. of Colorado, Boulder). Ann. Geophys., 22: 471-7(July-Sept. 1966).

Solar eclipse effects on the geomagnetic field are reviewed. The first unmistakable effect of an eclipse on the geomagnetic field was observed in the Pacific equatorial region during the total eclipse on October 12, 1958. In the magnetogram the horizontal component showed a definite change corresponding to the eclipse, although the vertical component and declination indicated no appreciable change because of the low sensitivity of the instruments and the low latitude of the observation site. It was confirmed from geomagnetic data obtained at other stations that there was no disturbance during the eclipse. Successful observations may be expected in South America when the next total solar eclipse occurs on November 12, 1966. The chance that the eclipse may occur during a geomagnetically quiet period is higher than in 1958, and the total eclipse zone crosses the magnetic equatorial zone near Lima, Peru. A net of geomagnetic stations along the eclipse path and in the magnetic equatorial zone (±5° dip) is recommended. The instruments for the declination and vertical components should provide high sensitivity. (BBB)

13466 MEASUREMENTS OF ½- TO 4-MeV TRAPPED PROTONS IN THE EQUATORIAL MAGNETOSPHERE. Paolini, F. R. (American Science and Engineering, Inc., Cambridge, Mass.); Theodoridis, G. C.; Hadley, W. C.; Katz, L.; Smart, D. Ann. Geophys., 22: 454-7(July-Sept. 1966).

The data reported were recorded by a Blue Scout Junior vertical probe launched on March 30, 1965, from Cape Kennedy, which reached a peak altitude of about 16,500 km. It crossed magnetic shells with L from about 2 to 3.7 at magnetic latitudes from 40° to the magnetic equator. The probe carried an instrument that measured intensities, energy spectra, and pitch angle distributions of 0.5- to 4-MeV protons with unprecedented accuracy. The high-resolution measurement of pitch-angle distributions furthermore allowed the derivation of intensities in regions not traversed by the probe. The proton spectrometer utilized a solid-state detector and pulse-height analysis; this spectrometer had a 6° field of view, and a 0.25-cm^2 detection area. Intensity profiles at constant magnetic latitude derived from pitch-angle distributions are shown. The maximum perpendicular intensity observed was about 4×10^6 protons/cm^2-sec-sterad, at $(B, L) \cong (0.006, 3.7)$ (maximum altitude). Energy spectra were of the shape exp $(-E/E_0)$ with $0.4 < E_0 < 0.6$ MeV. Pitch-angle distributions were symmetric about maxima at 90°. (BBB)

13467 THE EFFECT OF SOLAR ACTIVITY ON THE BOUNDARY FREQUENCIES OF THE E_S LAYER. Samardjiev, Dimitr (Geophysical Inst., Sofia). Pure Appl. Geophys., 64: 126-32(1966).

On the basis of data from three temperate latitude stations (Dourbes, Juliusruh and Moscow) for the 1957 to 1964 period, a study was made of the correlation between the midday values of the boundary frequencies of the E_S layer and the relative number of sun spots. A positive correlation with the solar cycle was established. The decrease in the boundary frequencies of the sporadic layer from 1957 to 1964 was about 25 per cent. The change in f_0E_S at a constant zenith angle of the Sun ($\chi = 75°$) was studied. A seasonal movement was outlined with a very well expressed double wave with maximal values of f_0E_S in the winter and the summer and minimal values during the equinoctial seasons. (auth)

13468 ORDER OF THE RECOMBINATION COEFFICIENT IN THE E LAYER. Serafimov, Kyryl Borissov (Geophysical Inst., Sofia). Pure Appl. Geophys., 64: 133-4(1966). (In Bulgarian).

A method for the determination of the order of the equivalent recombination coefficient α is suggested by using ionospheric data only. The increase in the speed of temporary changes in dN_m/dt in the electronic density N_mE is estimated for this purpose. The estimation is done with series of selected for the sake of expediency values of α, following at the same time which curves $\delta_m(t)$, determined in the course of work, will coincide most closely with the $\delta_m(t)$ measured. The changes in α were obtained in this way. The diurnal value of α is in the range of (0.5 to 1) 10^{-7} cm^3 sec, α being $>10^{-7}$ cm^3 sec a little after sunrise and a little prior to sunset. At cos $\chi < 0$, α by rule decreases and becomes $\alpha \leq 10^{-8}$ cm^3 sec. Explanations of the changes thus obtained in α are indicated, taking into consideration the relation of atomic and molecular ions, the rapid disappearance of positive ions at sunset with a higher recombination coefficient and eventual temperature changes. From the symmetry or asymmetry of the critical frequencies of f_0E at equal cos χ in the course of the day it can also be judged for the order of α. All those estimates show values of α in the range of 10^{-7} cm^3 sec. In the case of precise measurements of f_0E, not only the determination of the order but also the real value of α is possible. (auth)

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Refer also to abstracts 12727, 13096, 13157, 13565, and 13705.

13469 (AD-638802) THE MAGNETIC TORQUE OF IDEAL SUPERCONDUCTING TOROIDS. Final Report. King, E. E. (Naval Research Lab., Washington, D. C.). Aug. 9, 1966. 7p. (NRL-6414). CFSTI $3.00 cy, $0.65 mn.

Torsional experiments were performed with superconducting toroids. In order to discuss the results, knowledge of the expected behavior of an ideal superconducting toroid is needed. Equations which describe this ideal behavior were found in terms of three geometrically dependent constants, namely, the proportionality constants between components of the applied magnetic field and components of the magnetic moment of the toroid resulting from flux expulsion and any net current. Calculations of these three constants are available for toroids of circular cross sections. It is possible to estimate values for other than circular cross sections. (auth)

13470 (AD–640091) EXPERIMENTAL INVESTIGATION OF THE LAMBDA TRANSITION OF LIQUID HELIUM USING ACOUSTIC TECHNIQUES. Barmatz, Martin (California Univ., Los Angeles. Dept. of Physics). Aug. 1966. Contract Nonr-233(48). 112p. (TR–25). CFSTI $3.00 cy, $0.65 mn.

The velocity and attenuation of first sound were measured simultaneously to within microdegrees of the lambda transition of liquid helium. Measurements were made in the frequency range of 20 to 100 kc. With the high Q modes of the resonator, relative sound velocity measurements of one part in 100,000 could be obtained. Above the transition the velocity of sound had the temperature dependence predicted by the Pippard theory out to 5 millidegrees from the lambda point. The velocity of sound below the transition does not agree with the Pippard theory except within a fraction of a millidegree of the transition. The added temperature dependence beyond that expected from the Pippard theory can be fit to a series expansion in ΔT. This additional dependence is postulated to be due to the effects of the order parameter. The minimum of the sound velocity at the lambda point was found to be finite and equal to 217.05 m/sec. Using the convective properties of the resonator, the position of the density maximum was found to be approximately 6.2 millidegrees above the lambda point. (auth)

13471 (BNL–10979) THEORETICAL PROPERTIES OF MICROWAVE CAVITIES AT LOW TEMPERATURES. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). Jan. 6, 1967. Contract AT(30-2)-Gen-16. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The finite electric resistivity of metals at room temperatures is the cause for the classical skin effect and, consequently, for the surface losses in microwave cavities. The surface impedance of a superconductor was calculated considering the case of low frequencies and temperatures. The time dependence was assumed to be $e^{i\omega t}$. (M.O.W.)

13472 (ORNL–4063, pp 111-25) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

As was previously reported, development work is being done on "ribbon coils." This design is intended to be used when restricted space calls for magnet coils with very high current densities. The physical properties of "compound conductors" are important in the design of "stabilized" superconducting magnet coils. A compound conductor consists of superconducting wires or ribbons in close electrical and thermal contact with nonsuperconducting metallic material, the so-called "stabilizer." The performance of a compound conductor depends upon whether the superconductor is in the nonresistive or in the flux flow state. Both cases are considered here in a detailed study. It is shown that in the first case the compound conductor can be replaced by a simple equivalent network. In the second case an application of Kim's flux flow equation leads to a physical understanding of the often used phenomenological concept of the "overflow" of current from the superconductor to the stabilizer. Furthermore, the nonlinear heat transfer from the compound conductor to the surrounding liquid helium is considered. Numerical examples illustrate the new approach to understanding the performance of compound conductors. Finally, a brief report on nonstabilized superconductors is presented. Several attempts have been made to develop a theory of the current-carrying capacity of a hard superconducting wire founded on the basic properties of superconductors of the third kind. Such a theory would allow one to predict the critical current from data obtained by a magnetization experiment performed with a cylindrical sample in a longitudinal magnetic field. A theoretical criterion is presented for the current-carrying capacity of a hard superconducting wire restricted to the case of zero external field. It is shown that the critical current is determined by the fact that the radius of a circular field line inside the wire cannot be smaller than a certain critical length. A simple equation is derived for the value of this minimum radius. It depends on basic properties of the hard superconductor which can be determined by magnetization experiments. With Nb–25% Zr samples, magnetization and critical current experiments were made. Furthermore, oscillographic ac measurements were made on hard superconductors. The shape of the voltage–time curves can be explained by considering in an appropriate way a certain critical surface current and the magnitude of the pinning forces acting on the vortices in the type III superconductor. The surface currents can be observed with external fields up to $H_{c3} > H_{c2}$, whereas the bulk critical currents become zero at the upper critical field H_{c2}. The values of the critical surface currents and of the critical bulk current density obtained with these ac measurements are in good agreement with the results of static measurements. Finally, it is shown how the pinning force per unit volume and the pinning force acting on a single vortex line can be expressed as a function of the vortex line density. (M.O.W.)

13473 EFFECT OF UNIFORM ELECTRIC FIELDS UPON A WEAKLY INTERACTING BOSON GAS. Neidhardt, W. J. (Newark Coll. of Engineering, N. J.). Nuovo Cimento (10), 47B: 121-3(Jan. 11, 1967).

In recent years considerable work has been done on a weakly interacting Bose gas as such a system exhibits a behavior that can serve as a crude model of a boson superfluid like liquid helium. Bogoliubov has been able to show that the collective motion of such a Bose gas can be represented by an ensemble of noninteracting excitations. This paper shows how an external macroscopic parameter, a uniform electric field, can alter such an ensemble. In particular, its effect upon the excitation energy and average number of real particles in a given momentum state is calculated. The basis of the calculation is the fact that the field polarizes the Bose atoms thereby changing the effective interaction potential between them. (W.D.M.)

13474 ELECTRONIC MECHANISM FOR SUPERCONDUCTIVITY IN ALLOYS. Geilikman, B. T. Soviet Phys.-Solid State (Engl. Transl.), 8: 2032-8(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2536-46(Sept. 1966).

An electronic mechanism for superconductivity in metals having two intersecting bands is examined, which is similar to Little's mechanism for polymers. Expressions are obtained for the Green's and F functions, for the vertex part, and for the energy gap. Expressions also are obtained for the criterion for the existence of superconductivity and for the critical temperature. A similar mechanism is examined for alloys of a metal with a nonmetal. (auth)

13475 SUPERFLUID FILM FORMATION IN DILUTE LIQUID MIXTURES OF ^{4}He IN ^{3}He. Keyston, J. R. G.; Laheurte, J. P. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). Phys. Lett., 24A: 132-3(Jan. 16, 1967).

Superfluid film formation in dilute normal mixtures of ^{4}He in ^{3}He, observed at temperatures well above the bulk phase separation temperature, is interpreted as a surface phase separation influenced by the attractive forces between helium atoms and the container walls. (auth)

13476 SUPERCONDUCTIVITY IN β-BERYLLIUM AND RELATED PHASES. Olsen, C. E.; Matthias, B. T.; Hill, H. H. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Z. Phys., 200: 7-12(1967). (LA-DC-8215).

Two high temperature beryllium allotropes were stabilized at room temperature through the addition of transition elements. Superconductivity was observed in almost all of them. Beryllium films reported superconducting in the past appear in all probability to require the presence of transition element impurities, in order to show the phenomenon. (auth)

13477 EFFECT OF THE COULOMB INTERACTION BETWEEN d ELECTRONS AND OF THE d-s PAIRING INTERACTION ON SUPERCONDUCTIVITY IN DILUTE ALLOYS. Takanaka, Kenji; Takano, Fumihiko (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1080-2(Nov. 1966).

13478 ANISOTROPIC IMPURE SUPERCONDUCTOR AND RESONANCE SCATTERING. Nagashima, Tomitaro; Soda, Toshio (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 36: 887-900(Nov. 1966).

Both resonance scattering and impurity scattering effects in an anisotropic superconductor were investigated, extending the Markowitz–Kadanoff method for impurity scattering to the resonance scattering problem treated by Zuckerman. The decrease in T_c is computed; it contains both the resonance-scattering effect and the anisotropic part of the combination of resonance and impurity scattering. The decrease in the critical temperature is found to be a sum of the resonance effect and the mean free path effect in the anisotropic part for most physical cases, e.g. for $\Gamma \gg kT_c \gg E_d$ and $kT_c \gg \Gamma \gg E_d$ with $n_i|V|^2/(\pi kT_c)^2 \ll 1$; in the latter case there is a sharp decrease and in the former one a much weaker decrease. Here Γ is the broadening of the bound d state on each impurity due to the s-d interaction, E_d is the energy displacement of the d state from the Fermi level, n_i is the impurity density and V is the magnitude of the s-d interaction. The mean free path effect, appearing in the anisotropic term, is largely independent of the intrinsic properties of the impurities. However, for a few special situations, with the condition $n_i|V|^2/(\pi kT_c)^2 \gg 1$ for $\Gamma \gg kT_c \gtrsim E_d$, $E_d \gtrsim \Gamma \gg kT_c$ and $kT_c \gg \Gamma \gg E_d$, the decrease in T_c has not only an isotropic resonance part, but also amalgamated resonance and mean free path effects in the anisotropic part. The problem of degeneracy of the d bound state is also investigated. (auth)

13479 NUMBER–PHASE FLUCTUATIONS IN TWO-BAND SUPERCONDUCTORS. Leggett, A. J. (Magdalen Coll., Oxford, Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 901-30(Nov. 1966).

It is shown that in a clean two-band (transition-metal) superconductor there appears a collective excitation corresponding to small fluctuations of the relative phase of the two "condensates." In contrast to the transverse collective excitations in ordinary superconductors, the energy of this mode can be derived directly from existing experimental data; for Nb it lies about at the middle of the smaller single-particle gap. Direct experimental detection of this resonance is estimated to be rather beyond the limits of available techniques, but its effect on the ultrasound dispersion curve should be easily observable. The phenomenon is used to elucidate the physical nature of excitons in superconductors in general. (auth)

13480 ELECTRON–PHONON INTERACTIONS IN THE TRANSITION METALS. Leggett, A. J. (Magdalen Coll., Oxford. Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 931-54(Nov. 1966).

A generalized version of the Bardeen-Pines approach is applied to the problem of electron-phonon coupling in a two-band metal in the long-wavelength region, particular attention being paid to the question of how far observation of the phonon spectrum will give information on the low-lying collective excitations of the electron system predicted elsewhere. It is shown that (in contrast to the situation in a one-band metal) subsidiary poles due to electronic resonances should in principle appear in the phonon spectrum, but their direct observation is estimated to be experimentally unfeasible. On the other hand the existence of these resonances should lead to comparatively large effects on the ultrasound velocity; in particular, interesting effects of an observable order of magnitude are predicted in the ultrasound dispersion curve in a clean two-band superconductor at low temperatures. (auth)

13481 THERMOMOLECULAR PRESSURE DIFFERENCE MEASUREMENTS FOR PRECISION ^{3}He AND ^{4}He VAPOR-PRESSURE THERMOMETRY. Watkins, Reed A.; Taylor, William L.; Haubach, Walter J. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Chem. Phys., 46: 1007-18(Feb. 1, 1967).

Thermomolecular pressure differences due to thermal transpiration were measured to fine the corrections for low-temperature vapor-pressure thermometry using helium-3. The experimental apparatus consisted basically of several stainless-steel, pressure-sensing tubes, each connected to the same pressure container inside a cryostat. The upper, or warm, ends of the tubes were connected to differential pressure gages outside the cryostat. The gages measured the differences in warm end pressures between 0.29-cm radius reference tube and tubes of 0.14-, 0.055-, and 0.0271-cm radii for a variety of cold-end temperatures and pressures. The results for saturated and unsaturated helium-3 and unsaturated helium-4 are identical but greater at the maxima than the values computed from the semiempirical Weber–Schmidt equation, which was based on measurements with unsaturated helium-4. However, experimental data for saturated helium-4 in the low-pressure region were much higher than the Weber–Schmidt equation and the other data. This disagreement was attributed to superfluid film flow. An outline of the derivation of the differential equation describing thermal transpiration is given. Theoretical predictions for the high-pressure region of saturated helium-4 are in agreement with the experimental data. It is concluded that a revision of the Weber–Schmidt equation is needed for precision thermometry. (auth)

13482 EFFECT OF STRUCTURE ON THE SUPERCONDUCTING PROPERTIES OF VANADIUM AND NIOBIUM FOILS. van Gurp, G. J. Philips Res. Rep., 22: 10-35(Feb. 1967).

Magnetization and critical-current-density measurements of superconducting vanadium and niobium foils are reported. It is shown that in the mixed state pinning of flux lines is a maximum when these are parallel to grain boundaries and to the surface, i.e., when the magnetic field is parallel to these boundaries. This pinning causes anisotropic critical current density and magnetization with different field orientations in cold-rolled and in electrodeposited foils. From the temperature dependence of the critical density J_c, a value of 10^{-2} eV for flux-line pinning in cold-rolled vanadium by the dislocation cell structure is found in agreement with the temperature dependence of the resistance maximum in the mixed state. This barrier height is greater in the case of grain-boundary pinning. It is shown that the measured temperature dependence of J_c is evidence for the mechanism of flux-line pinning by local variation of the electronic mean free path. The peak effect in the critical current density is attributed to inhomogeneous current distribution due to surface superconductivity. (auth)

13483 EFFECT OF STRAIN AND IMPURITIES ON THE ULTRASONIC ATTENUATION IN SUPERCONDUCTING TIN. Chaudhuri, K. D.; Jain, M. C. (Univ. of Delhi). Phys. Lett., 24A: 84-6(Jan. 16, 1967).

The effect of strain and impurities on the ultrasonic attenuation in superconducting tin was studied. It was found that the energy gap is strongly dependent on the strain content of the specimen. In impure samples measurements revealed absorption peaks. (auth)

13484 NEW EFFECT IN THE LOW MAGNETIC FIELD ULTRASONIC ATTENUATION OF IMPURE SUPERCONDUCTING NIOBIUM. Gottlieb, M.; Jones, C. K. (Westinghouse Electric Corp., Pittsburgh). Phys. Lett., 24A: 97-8(Jan. 16, 1967).

Changes were found in the ultrasonic attenuation of superconducting niobium at magnetic fields less than 20% of H_{c1}. An interpretation is made based upon the effects of low-critical-field impurity phases. (auth)

13485 THEORY OF THE TOMASCH EFFECT. Wolfram, T.; Lehman, G. W. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Lett., 24A: 101-2(Jan. 16, 1967).

The imposition of boundary conditions on the solutions of Gorkov's equations for a finite superconducting film is shown to lead to a macroscopic quantization condition which results in oscillatory structure in the quasi-particle density of states. (auth)

13486 SCREENING CURRENTS IN A NORMAL METAL BACKED BY A SUPERCONDUCTOR. Deutscher, G.; Hurault, J. P. (Faculte des Sciences, Orsay, France). Phys. Lett., 24A: 102-4(Jan. 16, 1967).

The Meissner effect in a normal metal N in which superconductivity is induced by contact with a superconductor S, was studied by an rf permeability method. It was found that, when N itself is a superconductor below some critical temperature T_{cN}, a magnetic field can be screened, up to temperatures significantly higher than T_{cN}. (auth)

13487 CRITICAL CURRENTS OF ORGANIC SUPERCONDUCTORS. Atherton, D. L. (Ferranti-Packard Electric Ltd., Toronto). Phys. Lett., 24A: 107-8(Jan. 16, 1967).

It is suggested that if Little's proposal for a superconducting organic polymer is correct, this one dimensional superconductor should have a very large critical current, of the order of 2×10^9 A/cm^2, as a result of the restricted coherence length. (auth)

13488 SOME SUGGESTIONS ON THE PROBLEM OF SUPERCONDUCTIVITY. Linde, J. O. (Royal Inst. of Tech., Stockholm). Phys. Lett., 24A: 111-12(Jan. 16, 1967).

The possibility of a connection existing between the energy height of the Fermi level of a metal and the occurrence of superconductivity is discussed. Questions regarding possible mechanisms for the creation of a supercurrent are discussed and the applicability of the proposed model of a Cooper pair to the problem of magnetic flux quantization is tested. (auth)

13489 FLUX TRAPPING IN ROTATING SUPERCONDUCTORS. Sikora, P. T.; Carroll, K. J. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 24A: 78-9(Jan. 16, 1967).

A geometrical model is proposed to explain the dependence of flux trapping on angular velocity when superconducting Pb and Nb spheres in an external magnetic field are cooled through their transition temperatures while in rotation. (auth)

13490 SHIELDING OF MAGNETIC FIELDS BY SUPERCONDUCTING Pb AND Nb HOLLOW CYLINDERS. Hofer, W. O.; Rauch, H. (Oesterreichische Hochschule, Vienna). Acta Phys. Austr., 24: 147-52(1966). (In German).

The magnetic shielding behavior of Pb and Nb hollow cylinders at 4.2°K in a transverse external magnetic field was described. The total hysteresis of Pb hollow cylinders in Nb cylinders at 1.1 kOe was measured. The measurements were made with Hall generators at the temperature of liquid He. Both the occurrence of the intermediate state and the remaining remanence in the disconnection of the external field could be read from the measurement curves. (tr-auth)

13491 DETERMINATION OF LOSSES IN A Nb–25 PERCENT Zr SAMPLE OPERATING IN NORMAL AND SUPERCONDUCTING STATES. Claude, M. L.; Mailfert, M. A. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). Phys. Lett., 24A: 150-1(Jan. 30, 1967). (In French).

Results are indicated of effective losses in a type-II superconductor carrying a sinusoidal alternating current at 50 Hz and subjected to a transverse alternating magnetic field at the same frequency, regulated independently of the current. (tr-auth)

13492 NUCLEATION OF SUPERCONDUCTIVITY AT A TUNNELING BARRIER OF HIGH TRANSMISSIVITY. Boyd, R. G. (Univ. of California, Berkeley). Phys. Rev., 153: 444-9(Jan. 10, 1967). (UCRL-17024).

A calculation of the parallel critical field of a plane tunneling barrier in an otherwise homogeneous superconductor, valid for

$T_c - T \ll T_c$, is presented. A solution of the Ginzburg–Landau equation was found, which satisfies the semiphenomenological boundary conditions proposed by de Gennes. The critical field is significantly lower than H_{c3} when the tunneling current is of the same order of magnitude as the sheath current. When the ratio (tunneling current)/(sheath current) is small, it is proportional to $\xi(T)$. Since $\xi(T) \to \infty$ at T_c, in principle the critical field of a tunneling barrier of any transmissivity must go to H_{c2} as $T \to T_c$, although in practice this may be impossible to observe for small transmissivities because of the finite transition width at T_c. For the pure-metal, specular-barrier model at a fixed temperature T not too close to T_c, most of the drop in critical field from H_{c3} to H_{c2} occurs for transmissivities in the range 0.01 to 0.1. The effect predicted, if experimentally confirmed, may be useful as a tool for investigating the electronic properties of grain boundaries in polycrystalline metal. (auth)

13493 OSCILLATION OF TWO CYLINDERS IN LIQUID HELIUM. Hussey, R. G.; Good, B. J.; Reynolds, J. M. (Louisiana State Univ., Baton Rouge). Phys. Fluids, 10: 89-95(Jan. 1967).

A torsion pendulum was used to oscillate two solid cylinders in liquid helium II at subcritical velocities. The cylinders were sections of Plexiglas rod, constrained to move with their axes parallel to and equidistant from the axis of rotation by means of two parallel disks (end plates). Theoretical expressions based on the two-fluid model are derived for the added moment of inertia I_a and the logarithmic decrement $2\pi\delta$. The experimental results between 2.17 and 1.25°K are in close agreement with theory except for a small (1 to 2%) end effect on I_a. Penetration depths ranged between 0.03 and 0.59 of the cylinder radius. No dependence of I_a and δ on amplitude was observed for amplitudes up to 0.5 radius. (auth)

13494 MAGNETIZATION OF ELLIPSOIDAL SUPERCONDUCTORS. Cape, J. A.; Zimmerman, J. M. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 153: 416-21(Jan. 10, 1967).

A well-known result that can be rigorously deduced from Maxwell's equations and potential theory is that the magnetization M of any homogeneous, isotropic ellipsoid is related to the local field B and the external applied magnetic field H_0 by $H = B - 4\pi M = H_0 - 4\pi N \cdot M(H)$. The configuration matrix N, whose elements are the demagnetization coefficients, depends only on the shape of the ellipsoid. In particular, this relation provides a means for computing the magnetization M (as a function of H_0), if it is known for the special case of an infinitely long cylinder whose axis is aligned with H_0. This transformation has been commonly applied to systems for which the M(H) relationship is linear: $M = \chi H$, where χ is a constant. More generally, when the ellipsoid is homogeneous and isotropic, it is found that the transformation depends only on the assumption that M is a smooth, single-valued, and otherwise arbitrary function of the local field B. When the above result is applied to the well-known magnetization functions for superconductors it is found that, for spheroids whose symmetry axis is parallel to H_0, $4\pi M = -H_0/(1-n)$ (Meissner state) and $4\pi M = -[(H_{c2} - H_0)/(\gamma + n)H_0]H_0$ (mixed state), where $\gamma = (2\kappa^2 - 1)\beta$, and n is the element of N associated with the symmetry direction. The torque exerted on a superconducting spheroid whose symmetry axis is not aligned with H_0 is also computed. (auth)

13495 THEORY OF SOLID HELIUM. Iwamoto, Fumiaki; Namaizawa, Hiroshi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 234-43(1966).

Cohesive energy of solid helium for both isotopes at absolute temperature zero is computed by a new self-consistent method. The method contains no adjustable parameters. The calculated (experimental) value of cohesive energy at melting volume in unit of calorie per mole is −1.30 (−1.14) for helium three and −10.44 (−11.87) for helium four. (auth)

13496 THE ACOUSTIC IMPEDANCE OF LIQUID ^{3}He. Kirby, I. J.; Wilks, J. (Oxford Univ.). Phys. Lett., 24A: 60-1(Jan. 2, 1967).

The acoustic impedance Z of liquid ^{3}He has been measured at a frequency of 122 Mc. The transition to the zero sound region occurs at a mean temperature of 34 m°K. The total change in the value of Z/ρ is 14 ± 3 m sec^{-1}, where ρ is the density of the helium. These results are compared with other measurements of the transition to zero sound. (auth)

13497 RESISTIVITY AND TUNNELLING PROPERTIES OF PARAMAGNETIC ALLOY FILMS. Hedgcock, F. T.; Rizzuto, C. (McGill Univ., Montreal). Phys. Lett., 24A: 17-18(Jan. 2, 1967).

Evaporated films of zinc containing paramagnetic impurities are shown to exhibit a resistance minimum, suppression of the critical temperature and zero bias tunnelling anomalies. (auth)

13498 MUTUAL FRICTION AND THE STABILITY OF VORTEX LATTICES. Stauffer, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Lett., 24A: 72(Jan. 2, 1967).

A small mutual friction in helium II does not change the result that a triangular lattice of rectilinear vortices is stable, a square lattice or honeycomb lattice unstable. (auth)

13499 ENHANCEMENT OF SUPERCONDUCTING CRITICAL CURRENT DENSITY IN Nb_3Sn DIFFUSION LAYERS PRODUCED BY IRRADIATION WITH PROTONS. Bode, H. J.; Wohlleben, K. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Phys. Lett., 24A: 25-7(Jan. 2, 1967).

The irradiation of Nb_3Sn diffusion layers with increasing doses of energetic protons causes an increase of the superconducting critical current density $I_c(H_a)$ followed by a decrease at higher doses. The increase is independent of the magnetic field H_a. By comparing the results with neutron experiments the minimum size of the irradiation induced pinning centers may be estimated. (auth)

13500 LOW FREQUENCY RESONANCES IN PURE NIOBIUM. Renard, J. C.; Rocher, Y. A. Phys. Lett., 24A: 27-30(Jan. 2, 1967).

Observations are presented of low frequency and high-Q resonances in the mixed state of pure outgassed niobium. The resonant frequencies depend on the pinning introduced by defects. (auth)

13501 THEORY OF HYSTERESIS LOSSES IN NON-IDEAL SUPERCONDUCTORS. Irie, F.; Yamafuji, K. (Kyushu Univ., Fukuoka). Phys. Lett., 24A: 30-1(Jan. 2, 1967).

Hysteresis losses are calculated by using phenomenological equations of flux motion in nonideal superconductors developed recently. The parameters included in the equations are estimated by comparing the calculated magnetization curve with observed data. The results agree well with observed data. (auth)

13502 SOME DIFFICULTIES IN THE OBSERVATION OF THE FROEHLICH–TERREAUX QUASI-SUPERCONDUCTING STATE. Hulbert, J. A. (Royal Radar Establishment, Malvern, Eng.). Proc. Phys. Soc. (London), 90: 237-40(Jan. 1967).

Practical limitations in attainable magnetic fields and low temperatures make it unlikely that conditions for the observation of the high magnetic field quasi-superconducting state predicted by Fröhlich and Terreaux can be reached. In addition, in any real superconductive semiconductor, exchange effects in a magnetic field may induce a net electron-electron repulsion. (auth)

13503 BAND-STRUCTURE EFFECTS IN SUPERCONDUCTIVITY. I. FORMALISM. Garland, J. W. (Univ. of California, Berkeley, Cambridge Univ., Eng.). Phys. Rev., 153: 460-81 (Jan. 10, 1967).

Dyson equations are derived for the interacting electrons and phonons of a perfect crystal. A separation of the electron and phonon fields which is exact within either the Hartree or the Migdal approximation is effected. All umklapp processes and local-field corrections are included, but the hybridization of electronic bands and of phonon modes is given only implicitly. These equations reduce to previously obtained forms in the jellium approximation and to lowest order in r_s. The Nambu–Gor'kov formalism is used to derive equations for the superconducting energy gap. Since the Migdal approximation is not applicable to the treatment of the Coulomb interaction, other approximations are developed which yield either three-dimensional integral equations for an anisotropic energy gap $\Delta(k,k_0)$ or one-dimensional integral equations for an isotropic energy gap $\Delta(k,k_0)$ or one-dimensional integral equations for an isotropic energy gap $\Delta(k_0)$. An easy method for the calculation of the anisotropy of the energy gap $\Delta(k,k_0)$ in the simple metals is presented. The validity of these approximations is discussed and our equations are compared with those of previous authors. The strongly nonlinear homogeneous integral equation for $\Delta(k_0)$ is transformed into a quasilinear, inhomogeneous integral equation. This transformation immediately displays several interesting properties of the solution $\Delta(k_0)$ and yields a method for the rapid numerical calculation of $\Delta(k_0)$. (auth)

13504 ANISOTROPIC ENERGY GAP IN SUPERCONDUCTING WHITE TIN: SEMI-EMPIRICAL APPROACH. Bennett, Alan J. (Cambridge Univ., Eng.). Phys. Rev., 153: 482-7(Jan. 10, 1967).

The anisotropic energy gap in superconducting tin is found in terms of an expansion in tetragonal harmonics. The anisotropy coefficients are determined from a selection of Zavaritskii's single-crystal tunneling data by means of some results of a previous calculation of the anisotropic gap in lead. In particular, generalization of the latter work makes possible the separation of the contributions of different sheets of the Fermi surface to the tunneling current. The calculated gap variation is compared with that found in tunneling, acoustic attenuation, and infrared absorption experiments. (auth)

13505 MAGNETIC PROPERTIES OF SUPERCONDUCTING Mo–Re ALLOYS. Lerner, E. (Ohio State Univ., Columbus); Daunt, J. G.; Maxwell, E. Phys. Rev., 153: 487-92(Jan. 10, 1967).

Details of research carried out on the low-temperature properties of Mo–Re alloys in the superconducting state are given. Measurements were made on a 52–48% alloy of Mo–Re both unannealed and annealed, the alloy being in the form of fine wires. Micrograph studies were made to determine the percentage of the various phases present in each specimen. The low-temperature measurements covered observations of the magnetization as a function of applied magnetic field at various temperatures using two different techniques. The measurements yielded the critical magnetic fields H_{c1} and H_{c2} as a function of temperature and of the state of anneal, as well as of the transition temperature T_c. Estimates were made of $H_c(T)$ and the Ginzburg–Landau–Abrikosov–Gor'kov and Maki parameters $\kappa, \kappa_1(T)$, and $\kappa_3(T)$. Comparisons of the results are made with results obtained previously by us from resistivity measurements on the same alloy and by other authors on similar superconducting alloys; the comparisons show consistency in the data. Our evaluations of $\kappa_1(T)/\kappa_1(T_c)$ and of $\kappa_3(T)/\kappa_3(T_c)$ are consistent with the theory of Maki. (auth)

13506 ANISOTROPY AND TEMPERATURE DEPENDENCE OF THE UPPER CRITICAL FIELD OF TYPE-II SUPERCONDUCTORS. Hohenberg, P. C.; Werthamer, N. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 153: 493-7 (Jan. 10, 1967).

The anisotropic Ginzburg–Landau equation, originally proposed by Ginzburg and later derived from the microscopic theory by several workers, is unable to explain the anisotropy of H_{c2} observed in single crystals of type-II superconductors with cubic structure. The anisotropy is shown to arise from the first nonlocal corrections to the Ginzburg–Landau–Abrikosov–Gor'kov theory. Both the angular variation and the temperature dependence of the anisotropy as calculated here agree with that found recently in niobium. The temperature dependence of $H_{c2}(t)$ is derived for a polycrystalline but otherwise pure sample, and it is shown that Fermi-surface anisotropy increases the value of $H_{c2}(0)/|-H'_{c2}(1)|$ over that predicted for a spherical Fermi surface. (auth)

13507 DETERMINATION OF THE ANISOTROPY OF THE ENERGY GAP IN SUPERCONDUCTING LEAD BY SUPERCONDUCTIVE TUNNELING. Rochlin, G. I. (Univ. of Chicago). Phys. Rev., 153: 513-32(Jan. 10, 1967).

The anisotropy of the energy gap in superconducting Pb has been studied experimentally by the method of superconductive tunneling. Structure due to the Pb anisotropy has been observed in thick-Pb–versus–Al tunneling junctions at biases equal to the sum of the gaps. The theory has been analyzed and the experimental line shapes have been compared with theoretical predictions. Structure arising from the energy-gap anisotropy has also been observed in the subharmonic structure—below 2Δ—in Pb–versus–Pb tunneling junctions. These data have been interpreted in terms of the critical values—maxima, minima, and saddle points—of the energy-gap surface in k space. The double energy gap 2Δ has been observed to have a maximum at 2.98 ± 0.03 MeV and saddle points at 2.44 ± 0.02 and 2.55 ± 0.02 MeV. Additional structure has been observed in the subharmonic region which yields leading terms in the subharmonic series at 2.11 ± 0.02, 2.23 ± 0.02, 2.33 ± 0.02, 2.39 ± 0.02, and 2.61 ± 0.02 MeV. These latter values represent either critical values of the gap or the average of two such critical values. The present status of the theory of the subharmonic structure is discussed briefly. (auth)

13508 DIMENSIONALITY OF SUPERCONDUCTIVITY IN GRAPHITE LAMELLAR COMPOUNDS. Salzano, F. J.; Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 153: 533-4(Jan. 10, 1967). (BNL-10347).

The occurrence of superconductivity in some of the alkali-metal–graphite lamellar compounds, and its absence in others, has been used as evidence against the existence of two-dimensional superconductivity. The different superconducting transitions of these compounds are explained in terms of the different carrier populations in the planes and it is shown that no conclusion can be reached about two-dimensional super-conductivity. (auth)

13509 NUCLEAR RELAXATION MEASUREMENTS IN THE SUPERCONDUCTING AND NORMAL STATES OF SOME V_3X COMPOUNDS. Silbernagel, B. G. (Univ. of California, San Diego, La Jolla); Weger, M.; Clark, W. Gilbert; Wernick, J. H. Phys. Rev., 153: 535-46(Jan. 10, 1967).

The temperature variation of the spin–lattice relaxation time T_1 and the spin–spin relaxation time T_2 has been measured in five compounds possessing the β-W crystal structure and the chemical composition V_3X (X = Si, Ga, Ge, Pt, Ir). The temperature region under investigation was between 1.3 and 500°K. With the exception of V_3Ir, it is found that $1/T_1T$ has a temperature dependence for temperatures between 20 and 500°K which indicates that the conduction electrons have an unusually large density of states at the Fermi surface. The effect is greatest for those compounds possessing a high superconducting transition temperature T_c (e.g., V_3Si and V_3Ga). An additional increase in $1/T_1T$ is observed at the temperature of the recently discovered crystal-structure transformation in V_3Si; similar increases have also been observed in V_3Ge and V_3Pt, which indicates that the change in crystal structure has a substantial effect on the electron bands. Measurements of T_1 in the superconducting state show the presence of the energy gap. At temperatures below $\frac{1}{4}$ T_c, a contribution to the spin-lattice relaxation rate in addition to that expected of a simple energy gap in V_3Si is observed. A marked increase in T_2 is observed in the superconducting state. Also, a dependence of T_2 on the magnitude of the pulsed rf field strength, the magnetic field, and the rate at which the external magnetic field is turned on (dH_0/dt) is observed in the superconducting state. An interpretation of these changes in T_2 based on microscopic field inhomogeneities caused by a fluxoid structure is presented. Measurements of the ac magnetic susceptibility of V_3Si show a dependence on dH_0/dt similar to that of T_2. (auth)

13510 DETERMINATION OF $\kappa_1(T)$ AND $\kappa_2(T)$ FOR TYPE-II SUPERCONDUCTORS WITH ARBITRARY IMPURITY CONCENTRATION. Eilenberger, Gert (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 153: 584-98(Jan. 10, 1967).

Formulas are derived for the constants κ_1 and κ_2 of superconducting alloys for arbitrary temperatures and impurity concentrations. Beginning with Gorkov's equations in matrix form, the free-energy density up to fourth order in $|\Delta|$ is calculated, using Abrikosov's assumption of a fluxoid lattice. The impurities are treated by the usual averaging technique, retaining only s and p scattering, and a special technique is developed to treat exactly the nonvanishing commutator of different components of the gauge-invariant derivative. The results contain the already known limiting cases. Intermediate values are obtained by performing machine calculations using the general formulas developed here. It is found that the values of κ_1 and κ_2 drop relatively strongly even for small impurity concentration, and also depend unexpectedly strongly on the ratio of s and p scattering. The recent result of Caroli, Cyrot, and de Gennes is confirmed according to which κ_2 is approximately equal to κ_1 in the dirty limit. (auth)

13511 INCREASE OF THE ANISOTROPY OF THE ENERGY GAP IN SUPERCONDUCTING THALLIUM UNDER PRESSURE. Gey, Wolfgang (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 153: 422-8(Jan. 10, 1967).

A study has been made of the dependence of the superconducting transition temperature of thallium on the density of lattice defects due to plastic deformation, as a function of hydrostatic pressures up to 4 kbar. The change in critical temperature with resistivity ratio is found to be pressure-dependent. It can be accounted for by a theory of gap anisotropy given by Markowitz and Kadanoff and yields a strongly pressure-dependent anisotropy parameter $\lambda\langle a^2\rangle$ which varies from 0.0008 at zero pressure to 0.007 at p = 4 kbar. Only a little change in the "valence" effect with pressure is observed. The well-known anomalous enhancement of the transition temperature of thallium at pressures up to 2 kbar can be explained quantitatively by this increase of the gap anisotropy under pressure. (auth)

13512 ANOMALOUS SCATTERING BY MAGNETIC IMPURITIES IN SUPERCONDUCTORS. Maki, Kazumi (CNRS, Orsay, France). Phys. Rev., 153: 428-34(Jan. 10, 1967).

The effect of magnetic impurities in superconductors is studied by using the dispersion equations, which are simple extensions of those introduced by Suhl. In the case of a single impurity, it is found that, if $T_{c0} > T_r$ (where T_{c0} is the superconducting transition temperature and T_r is the Suhl–Abrikosov resonance temperature), a pair of bound states appear in the energy gap, while if $T_{c0} < T_r$, resonances appear at low temperatures. Also, self-consistent equations are constructed to treat the case of dilute concentration of impurity atoms. In the gapless region it is established that the Abrikosov–Gor'kov expressions are valid, except that τ_s in their theory must be replaced by the exact frequency-dependent spin-flip lifetime $\tau_s(\omega)$ in the normal state. (auth)

13513 CALORIMETRIC EVIDENCE FOR PAULI-PARAMAGNETIC SUPERCONDUCTIVITY. Barnes, L. J. (Atomics International, Canoga Park, Calif.); Hake, R. R. Phys. Rev., 153: 435-7(Jan. 10, 1967).

Specific-heat measurements at $0 \leq H \leq 29$kG, $0.33 \leq T/T_c \leq 1$, on the extreme ($\kappa_G \approx 67$) type-II superconducting alloy Ti–16 at. % Mo (previously shown to display reversible paramagnetic magne-

tization in the superconducting mixed state) (1) confirm the second-order nature of the upper-critical-field transition between the paramagnetic mixed and paramagnetic normal states at $H_3(T)$ down to $T/T_c = 0.76$, (2) show that the mixed state remains a single thermodynamic phase in the paramagnetic region, and (3) indicate that $\kappa_1 \equiv H_w/\sqrt{2}H_c$ and $\kappa_2 \propto \{\partial[4\pi(M_S - M_N)]/\partial H\}^{-1/2}_{H_3}$ (where H_c is the thermodynamic critical field, and M_S and M_N are superconducting mixed-state and normal-state magnetizations), both decrease with decrease of T. (auth)

13514 IMPURITY DEPENDENCE OF THE CRITICAL FIELD IN ANISOTROPIC SUPERCONDUCTORS. Clem, John R. (Univ. of Maryland, College Park). Phys. Rev., 153: 449-54(Jan. 10, 1967).

The effect of anisotropy of the superconducting energy-gap parameter upon the critical field H_c when nonmagnetic impurities are present is theoretically examined. Gap anisotropy is shown to produce corrections, of the order of the mean-squared anisotropy $\langle a^2 \rangle$, to the isotropic-gap values of H_c. With an anisotropic BCS-like model introduced by Markowitz and Kadanoff, the reduction of these corrections as impurities are added is calculated. An upward shift in the value of $H_3^2/8\pi\gamma T_c^2$ and in the curve of $h = H_c/H_0$ vs $t = T/T_c$ results when impurities are added to an anisotropic, moderately weak-coupling superconductor. Expressions for these shifts are given. (auth)

13515 VOLUME AND TEMPERATURE DEPENDENCE OF THE GRUENEISEN PARAMETER OF hcp ^{4}He. Ahlers, G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 24A: 152-3(Jan. 30, 1967).

Values of the Grüneisen parameter γ' have been derived for hcp ^{4}He as a function of volume and temperature. γ' decreased linearly with volume at a rate of 0.083 $(cm^3/mole)^{-1}$ at 0°K and is temperature-dependent. (auth)

13516 POSSIBLE THEORETICAL IMPLICATION OF THE OBSERVED HALF-INTEGER VALUES OF QUANTUM OF CIRCULATION IN HELIUM II. Di Castro, C. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Phys. Lett., 24A: 191-2(Jan. 30, 1967).

Some experimental evidence of the existence of half-integer values of quanta of circulation in helium II are assumed as a basis for envisaging the possibility of the simultaneous existence of condensation of the order of the total number of particles in the single- and two-particle reduced density matrix. (auth)

13517 FLUCTUATIONS IN A SUPERFLUID NEAR T_λ. Tyson J. A. (Univ. of Chicago. Univ. of Wisconsin, Madison). Phys. Lett., 24A: 183-4(Jan. 30, 1967).

Macroscopic phase and amplitude fluctuations in the order parameter for the superfluid are examined and the short-range coherence lengths, scaling laws, susceptibilities, and the anomalous specific heat are discussed. (auth)

13518 TRANSITION TEMPERATURE AND COMPOSITION OF THE SUPERCONDUCTING Nb_3Sn PHASE. Bode, H. J.; Uzel, Y. (Siemens Aktiengesellschaft, Erlangen, Ger.). Phys. Lett., 24A: 141-2(Jan. 30, 1967).

The superconducting transition temperature within the Nb_3Sn phase prepared by vapor deposition decreases linearly with increasing Nb content. This may be caused by a shift in the electron energy bands. For comparison Nb_3Sn diffusion layers are examined with respect to composition and T_c values. (auth)

13519 THERMAL CONDUCTION IN BISMUTH AT LIQUID HELIUM TEMPERATURES. Bhagat, S. M.; Manchon, D. D. Jr. (Univ. of Maryland, College Park). Contract SD-101. Phys. Lett., 24A: 147-8(Jan. 30, 1967).

The thermal conductivity of single-crystal bismuth between 1 and 2°K is found to be anisotropic not only in magnitude but also in temperature dependence. A 500 Oe field applied transverse to the sample axis reduces the conduction and also alters its temperature dependence. (auth)

Plasma and Thermonuclear Physics

13520 (AGARD-CP-8(Vol.1)) FUNDAMENTAL STUDIES OF IONS AND PLASMAS. VOLUME I. Proceedings of the 26th Meeting of the Propulsion and Energetics Panel held at Pisa, Italy, 6–10 September 1965. Wilsted, H. Dean (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). Sept. 1965. 395p. (CONF-650983).

Separate abstracts were prepared for 4 of the 12 papers. The remaining eight papers were not in the scope of NSA and hence omitted. (M.O.W.)

For abstracts of individual papers see: 13540, 13554, 13600, and 13601.

13521 (AGARD-CP-8(Vol.2)) FUNDAMENTAL STUDIES OF IONS AND PLASMAS. VOLUME II. Proceedings of the 26th Meeting of the Propulsion and Energetics Panel held at Pisa, Italy, 6–10 September 1965. Wilsted, H. Dean (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). Sept. 1965. 352p. (CONF-650983).

Separate abstracts were prepared for 11 of the 14 included papers. One paper appeared previously in NSA as 20: 17510. The remaining two papers were not in the scope of NSA and hence omitted. (M.O.W.)

For abstracts of individual papers see: 13541–13543, 13555–13561, and 13602.

13522 (N-66-26123) DETECTION OF THE PLASMA COMPONENT OF MAGNETOHYDRODYNAMIC WAVES IN SPACE. Neugebauer, Marcia (Jet Propulsion Lab., Pasadena, Calif.). June 12, 1962. Contract NAS7-100. 32p. (NASA-CR-74996; JPL-TM-33-93). CFSTI $3.00 cy, $0.65 mn.

The fundamental structure of low-frequency magnetohydrodynamic waves in interplanetary space is analyzed with respect to variations of the magnetic field, the plasma velocity, and the plasma density. The analyses have been conducted in order to (a) determine the time profile of such waves as seen by the types of plasma detectors presently used or planned for use in the direct measurement of the properties of the interplanetary plasma, and (b) aid in the design of second-generation detectors specifically suited to the analysis of magnetohydrodynamic waves in space. It is concluded that plasma detectors with flat resolution functions allow a reasonably faithful reproduction of the waveform of the plasma motion, but that this type of instrument suffers from blind spots for the detection of some transverse hydromagnetic waves. The type of instrument with a peaked resolution function, on the other hand, is not troubled by blind spots but creates a large amount of distortion of the plasma waveform. It is possible, however, to determine fluid velocity and density of the plasma by simultaneously monitoring each member of a group of at least four plasma detectors of conventional design. (auth)

13523 (ORNL-4063) THERMONUCLEAR DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1966. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 154p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared for 10 individual sections. (M.O.W.)

For abstracts of individual sections see: 13348, 13349, 13472, 13527–13532, and 13609.

13524 (AEC-tr-6675) NUCLEAR FUSION (TRANSLATED SELECTED ARTICLES). Translation of Nucl. Fusion, 6: 169-81; 188-99; 212-14; 228-30(1966). 88p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Abstracts for the 5 foreign-language papers translated here appeared previously in NSA as: 20: 46857, 46858, 46860, 46863, and 46866. (M.O.W.)

Confinement and Heating of Plasma

13525 (MATT-523) INTERPRETATION OF EXPERIMENTS ON COLLISIONAL DRIFT MODES. Coppi, B.; Hendel, H. W.; Perkins, F.; Politzer, P. A. (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1967. Contract AT(30-1)-1238. 13p. (CONF-670104-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

Experiments results are reported on low-temperature alkali plasmas in strong magnetic fields in terms of collisional drift modes, in which diffusion over the transverse wavelength, resulting from ion–ion collisions, plays an important role. These experiments determine frequencies, amplitudes, and azimuthal mode numbers of steady-state drift waves as functions of magnetic field strength and ion density. (M.O.W.)

13526 (N-66-26751) GENERALIZED LANDAU KINETIC EQUATION DESCRIBING THE TRANSVERSE DIFFUSION OF A NONGYROTROPIC PLASMA COLUMN. Haggerty, Michael J. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Mar. 1966. 27p. (NASA-CR-75194; BN-443). CFSTI $3.00 cy, $0.65 mn.

Some further preliminary results are reported on the application of the plasma kinetic theory of Prigogine and Balescu to a plasma column in a uniform magnetic field. A relatively simple kinetic equation for the one-particle distribution function is obtained. The resulting augmented kinetic theory is expected to describe a greater variety of diffusion phenomena. A multicomponent plasma is considered, but the effect of the macroscopic

transverse electric field (due to charge separation) on the local interactions has not yet been calculated. The plasma is assumed to be homogeneous in the direction of the magnetic field, but an arbitrary inhomogeneity across the field is allowed. A collision integral due to Eleonskii, Zyryanov, and Silin can be reproduced as a special case. Contact is also made with the recent work by Sundaresan on the homogeneous nongyrotropic plasma. A method of properly including collective effects is suggested. (auth)

13527 (ORNL–4063, pp 1-9) INJECTION AND ACCUMULATION: NEUTRAL INJECTION EXPERIMENTS (DCX-1,5). Colchin, R. J.; Dunlap, J. L.; Edwards, R. S.; Massengill, L. A.; Postma, H.; Reinhardt, R. G.; Schill, W. J.; Wells, E. R. (Oak Ridge National Lab., Tenn.).

In these experiments 15-keV hydrogen atoms are formed and injected into the magnetic mirror field of the DCX-1 facility. The principal motivation is the development of the neutral injector, the beam injection and burial lines, a vacuum system, and special diagnostic equipment which will be required for the DCX-3 facility. The energetic neutrals are formed from 30-keV H_2^+ within a magnesium vapor cell, and up to 40 mA (equivalent) of these neutrals have been injected. The Lorentz trapping fraction is 1.2×10^{-4}, and hot-ion lifetimes of 80 msec for an 18-mA beam and 160 msec for a 7-mA beam have been recorded. Central hot-ion densities of 4×10^8 cm^{-3} have been obtained, apparently not limited by flute instability. A comparison with data from the ALICE facility suggests that the absence of this limitation may be the result of cold-plasma effects. Properties of the magnesium vapor cell and of an energy analyzer for low-energy charge-exchange neutrals are also described. (auth)

13528 (ORNL–4063, pp 10-20) INJECTION AND ACCUMULATION: MULTIPLE-PASS EXPERIMENTS (DCX-2). Bell, P. R.; Culver, J. S.; Davis, R. C.; (and others) (Oak Ridge National Lab., Tenn.).

Progress is reported in three areas: improved understanding of injected beam properties, studies of regimes of increased plasma density, and improvements in energy analyzer diagnostics and in vacuum. The distinct peaks seen previously in the pitch-angle scan of the molecular-ion beam are consistent with calculated single-particle orbits for the turns the beam makes from the injector to the detector. Plasma densities obtained with hydrogen- or deuterium-arc dissociation are an order of magnitude higher than those attained with gas dissociation. At these high densities (up to 5×10^9 hot protons/cm^3), bursts of rf appear even during decay of the plasma. Accompanying these bursts are small but discernibly increased charge-exchange losses. These correlations are related to the velocity distribution of the trapped particles. At the lower densities obtained with gas dissociation, the radial distribution of the plasma potential has been measured. A much improved energy analyzer is described, and finally the method for obtaining good vacuums in the presence of large hydrogen-gas throughput is given. (auth)

13529 (ORNL–4063, pp 21-8) ELECTRON–CYCLOTRON HEATING. (Oak Ridge National Lab., Tenn.).

The INTEREM facility is being modified to accommodate a higher intensity 20-keV neutral beam. Spectral studies in the INTEREM ECH plasma suggest the formation of the fast "Franck–Condon" neutrals (N^0) when N_2 is used as a support gas. The ELMO facility has been operated in the double-folded cusp, mirror, and "stuffed" folded cusp magnetic configuration. Macroscopic plasma instabilities are evident, even when the plasma is created and contained in the positive-gradient magnetic field of the folded cusp. (auth)

13530 (ORNL–4063, pp 29-35) INJECTION AND ACCUMULATION: NEUTRAL INJECTION INTO MINIMUM |B| (DCX-3 MAGNET DESIGN). Coffey, D. L.; Dunlap, J. L.; Luton, J. N.; Parker, C. E.; Potts, J. F.; Rankin, Mozelle; Watts, H. L. (Oak Ridge National Lab., Tenn.).

The DCX-3 program is a study of stability properties of a plasma formed by injection of energetic neutral atoms into a minimum |B| trap. The initial experiments in this program will utilize Lorentz trapping a mirror-quadrupole field. Two designs of the magnetic bottle are reviewed. Both are steady-state rather than pulsed systems, and in each the maximum central field value is 20 kG. One uses coils formed of copper ribbon, water cooled, and energized by conventional motor–generator sets. The other uses superconducting coils. At present the superconducting system appears the more desirable. (auth)

13531 (ORNL–4063, pp 36-70) PLASMA PHYSICS. (Oak Ridge National Lab., Tenn.).

In beam-plasma interactions in Burnout V a source of energetic tritons and protons has been localized to the plasma volume. The reaction rate of these D–D products is consistent with the previously measured plasma ion temperature, density, and volume. Measurements were made using detection of tritons on cellulose nitrate and of protons by both scintillation and nuclear emulsion techniques. Ion heating has been observed in another electron-beam–plasma interaction. In order to have energetic ions, in this case, the electron beam must be modulated at frequencies near the ion plasma frequency (which is also close to the lower hybrid frequency). The beam is injected axially into a 550-G magnetic mirror field and creates a density near 10^9/cm^3. The energetic charge-exchanged ions are reionized and analyzed; the maximum variations available did not permit ion energies greater than 200 eV. Using the "electron temperature converter," studies were made of the velocity dependence of ionic sound waves on electron temperature and of the electron temperature dependence of Landau damping of ionic sound waves. The addition of helium ions to a xenon plasma verified the prediction of Landau damping of ionic sound waves by ions in yet another way. A theoretical treatment shows that in a cold plasma, externally imposed oscillating electric fields excite transverse electromagnetic waves which propagate perpendicular to it. The density of the intermediate energy group (2-keV electrons) in the hot electron blanket experiment has been increased to 5×10^{11} cm^{-3} by simultaneous use of two radially displaced electron beams. But when the central magnet field was increased by a factor of 3.5 the plasma density decreased by a factor of 5. Additional data on the vacuum ultraviolet absorption method for analysis of ion densities in energetic carbon arcs are presented. Higher arc currents increase the concentration of C^{3+} and probably reduce the activity of the excitation-heating process involving C^{2+} and C^{2+*}, thus explaining the reduced ion temperatures in higher current arcs. Mass spectrometric analysis of carbon ions in the peripheral region of the arc supports the absorption measurements of ΣC^{2+} and C^{3+} as the most prominent ion species. The near-resonance nature of the intermediate reaction step, $C^{2+*} + C^{2+*} \rightarrow C^{2+\prime} + 0.29$ eV, is discussed in terms of the Massey–Hasted adiabatic maximum criterion and in terms of the isoelectronic sequence Be, B^+, C^{2+}, N^{3+}, and O^{4+}. A facility is nearing completion which will permit measurement of the radiation from a magnetically supported high-density arc at high pressures. This measurement will allow quantitative assessment of the feasibility of using gas confinement to contain energetic plasmas. The use of the inductive end walls suggested by Briggs and Neil for suppressing the negative-mass instability has not proven to be effective in reducing the calutron instability. Studies of the plasma confinement properties of a toroidal multipole configuration have started. To avoid plasma losses on hangers, magnetic levitation of the internal conducting hoops is required. A small-scale model has successfully demonstrated levitation of two coplanar concentric conducting hoops (a quadrupole). Peak fields were 2 kG, and useful times available for plasma containment were 8 msec. (auth)

13532 (ORNL–4063, pp 126-34) VACUUM STUDIES. Strehlow, R. A.; Richardson, D. M. (Oak Ridge National Lab., Tenn.).

Chemical analysis of the DCX-2 vacuum system using residual gas mass spectra was performed in detail for one day's operation. Experimental distinction between four types of impurity species was made. These four groups of impurity gases are classified on the basis of their origin: (1) extraneous species associated with the mass spectrometer, (2) "base" pressure impurities, (3) contaminants in the bleed-gas manifold, and (4) gases generated during ion beam injection. Water was found to be the principal member of the second and third classes listed, while several low-molecular-weight hydrocarbons were found to be generated during beam injection. A study of mass discrimination in the spectrometer is described which permitted the improvement in the quantitative analysis of these data. In other research an attempt was made to study the kinetics of water sorption on stainless steel at exposure pressures less than 10^{-4} torr. The results followed chemisorption kinetics. In a fourth study a white solid decomposition product of a silicone diffusion pump fluid was identified. A deposit of this material had impaired the pump's speed. (auth)

13533 (UCRL–7744(Rev.2)) MAFCO: A MAGNETIC FIELD CODE FOR HANDLING GENERAL CURRENT ELEMENTS IN THREE DIMENSIONS. Perkins, W. A.; Brown, J. C. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 9, 1966. Contract W-7405-eng-48. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

MAFCO, which is written in FORTRAN language, can be used on the IBM 7094 and CDC 6600 and other similar computers which will compile a machine language code from a FORTRAN deck. The purpose of this code is to take a given set of current-carrying elements of arbitrary geometry and calculate the magnetic field $\vec{B}$ at any point in space and also the continuation of the magnetic field line (line of force) passing through any desired point in space. In practice, however, computer memory and available machine time usually require that most of the current-carrying conductors be approximated by straight lines, circular loops, and arcs of circles. (auth)

13534 TOROIDAL CONTAINMENT OF A PLASMA. Grad, Harold (New York Univ.). Phys. Fluids, 10: 137-54(Jan. 1967).

The question of plasma containment in a torus is much more complicated than in an open-ended mirror system. Serious questions arise of the nonexistence of flux surfaces, of noncontained particle drifts, and of nonexistence of self-consistent equilibria at small gyroradius. (auth)

13535 SELF-CONSISTENT DESCRIPTION OF A WARM STATIONARY PLASMA IN A UNIFORMLY SHEARED MAGNETIC FIELD. Sestero, A. (IAEA, Trieste, Italy. EURATOM-CNEN, Frascati, Italy). Phys. Fluids, 10: 193-7(Jan. 1967).

An exact, self-consistent solution of the system of Vlasov's plus Maxwell's equations is derived, describing a warm stationary plasma in a uniformly sheared magnetic field. It is found that there is no upper limit for the rate of shear; that is, the distance over which the direction of the magnetic field rotates of an angle 2π can be as small as desired; in particular this distance can be smaller than the ion or even the electron Larmor radius. Within the assumed model, for any value of plasma density, magnetic field strength and rate of shear a priori assigned, there exists a one-parameter family of solutions, differing from each other essentially for the fraction of the total current that goes into ion or electron current, respectively. The two currents can also flow in opposite directions, thus subtracting from each other in producing the net total current; in this case, however, they cannot separately exceed certain limiting values, set by the requirement of integrability for the distribution functions. (auth)

13536 REDUCED PLASMA DIFFUSION IN POSITIVE GRADIENT MAGNETIC FIELD CONFIGURATIONS. Schwirzke, Fred (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 10: 183-8(Jan. 1967).

The effective electron- and ion-diffusion coefficients have been measured in magnetic-field configurations with positive, zero, and negative gradients of the magnetic induction B_z across the field. The radial density profiles are approximately the same for a mirror configuration $\partial B_z/\partial r < 0$ and a uniform field $\partial B_z/\partial r = 0$. The measured electron-diffusion coefficient is by orders of magnitude larger than the collisional one and shows the 1/B dependence of the Bohm-type diffusion process, $D_{\perp} = C\ kT_e/B$. The factor C has been determined to $C \sim 10^{-2}$. The noise level diminishes and the density profiles become steeper with increasing positive gradients, $\partial B_z/\partial r > 0$, thus showing reduced plasma diffusion. A sharp drop of the electron saturation current to the probe indicates that the anomalous diffusion of the electrons is strongly reduced in certain regions where the radial electric field is weak. The stabilizing effect of an average minimum-B field has been confirmed experimentally. (auth)

13537 FLUCTUATIONS IN THE PLASMA OF THE MODEL STELLARATOR. Young, K. M. (Princeton Univ., N. J.). Phys. Fluids, 10: 213-24(Jan. 1967). (MATT-422).

Low m-number fluctuations of floating potential, density, and magnetic fields have been investigated in ohmically heated discharges in the C stellarator. The azimuthal velocity of the perturbations reverses direction near $v_D/v_i = 1$ (v_D is the electron drift velocity due to current and v_i is the ion thermal velocity). For $v_D/v_i \gtrsim 1$, the wave moves at about the electron diamagnetic drift velocity and detailed probe measurements are consistent with the mode being the current-driven universal instability: the amplitude and relative phasing of the fluctuations indicate that the low-m fluctuations can cause the plasma loss. For $v_D/v_i \lesssim 1$, the wave moves close to the plasma $E_r \times B_\theta$ velocity and measurements are consistent with the resistive-g mode: measurement accuracy prevents a definite statement on the relationship between the fluctuations and the plasma loss. (auth)

13538 EQUILIBRIUM OF ELECTRON CLOUDS IN TOROIDAL MAGNETIC FIELDS. Daugherty, J. D.; Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 10: 155-61(Jan. 1967).

The self-consistent equilibrium configurations available to low-density ($q = \omega_p^2/\omega_c^2 \ll 1$) toroidal electron clouds under the influence of an external magnetic field and the electric fields due to space and image charges are discussed. The equilibria are dynamic rather than static, but steady. ∇B, centrifugal, and other drifts are shown to be unimportant, in contrast to the situation in toroidal neutral plasmas. Typical equilibria are shown in detail, to zero order in q. The construction of equilibria accurate to order q is shown to be possible but is not carried out in detail. Questions relating to the stability of these equilibria are not treated. (auth)

13539 DESTRUCTION OF MAGNETIC SURFACES BY MAGNETIC FIELD IRREGULARITIES. Rosenbluth, M. N. (IAEA, Trieste, Italy); Sagdeev, R. Z.; Taylor, J. B.; Zaslavski, G. M. Nucl. Fusion, 6: 297-300(Dec. 1966).

A perturbation theory analogous to that of quasilinear theory is developed to treat the behavior of magnetic surfaces, in particular to estimate their stability against field irregularities. The method exploits the similarity between the Vlasov equation and the Liouville equation for field lines. It was found that a very important role is played by field resonances, that isolated resonances have a limited effect, extended over a finite width which was estimated. (auth)

Diagnostics of Plasma

Refer also to abstracts 12721, 12726, and 13528.

13540 (AGARD-CP-8(Vol.1), pp 325-52) SOME R. F. AND SPECTROSCOPIC DIAGNOSTIC METHODS OF A HELIUM PLASMA IN A MAGNETIC FIELD. Caldirola, P.; Agnello, V.; Barassi, N.; Finzi, U.; Fontanesi, M.; Sindoni, E. (Milan Univ. (Italy). Istituto di Scienze Fisiche).

Some methods for the diagnostics of a low density plasma in the presence of a steady magnetic field are described. Plasma is produced in a low pressure helium by an rf field near gyromagnetic resonance condition. Breakdown fields were measured for several values of the magnetic fields and for some container shapes. A spectroscopic method was applied to measure electron kinetic temperature. A method based on admittance measurements was used to evaluate density. Another diagnostic technique developed for the measurement of electron density by means of excitation of characteristic resonances is described. (auth)

13541 (AGARD-CP-8(Vol.2), pp 385-418) DIAGNOSIS OF A PLASMA BEAM EXTRACTED FROM AN ELECTRON-BOMBARDMENT ION SOURCE. Clayden, W. A.; Hurdle, C. V. (Royal Armament Research and Development Establishment, Fort Halstead (England)).

A plasma beam facility has been built to study the interaction between bodies moving at high speeds in the ionosphere and the ambient charged particles. The plasma beam is extracted from an electron-bombardment ion source similar in principle to those used for ion engines. The properties of the plasma beam have been studied with various types of Langmuir probes and ion traps operating in free molecule flow. Data from these probes have been analyzed to yield the distribution of ion velocity, density, speed ratio and temperature, the electron temperature and the density of slowly moving ions which result from charged exchange between ions in the beam and the neutral particles in the beam chamber. Typically the ion velocity in the beam $\simeq 2 \times 10^6$ cm/sec, the ion density $\simeq 10^8$ ions/cm^3 and the ion and electron temperatures $\simeq 10^{4\circ}$K. It is shown that many of the flow conditions appropriate to small satellite in the ionosphere are simulated when a body $\simeq 1$ cm is placed in the beam. (auth)

13542 (AGARD-CP-8(Vol.2), pp 517-27) LASER INTERFEROMETER MEASUREMENTS OF RAPID ELECTRON DENSITY CHANGES IN A PLASMA. Wheeler, C. B.; Dangor, A. E. (Imperial Coll. of Science and Tech., London (England)).

A He–Ne laser was constructed and used with various specialized types of interferometer to measure plasma electron density. Particular emphasis was given to the time resolution of the various interferometers since in nearly all experimental plasmas density variations take place with extreme rapidity. In a series of preliminary experiments it was found that a modified Mach–Zehnder interferometer was the fastest system; it could measure path differences about 10 times more rapidly than the corresponding Fabry–Perot arrangements. Results of density measurements using a modified Fabry–Perot system are presented as a function of time for a range of discharge parameters. At very high number densities the fringes disappeared. The disappearance has been shown to be due to refraction of the laser beam in the plasma due to radial electron density gradients. The long plasma length in these experiments made this a significant effort, but short lengths of uniform plasma can avoid this limitation. (auth)

13543 (AGARD-CP-8(Vol.2) pp 529-72) PLASMA DIAGNOSTICS WITH GASEOUS LASERS. Verdeyen, J. T.; Gerardo, J. B. (Illinois Univ., Urbana, Gaseous Electronics Lab.).

The basic principles of the three-mirror laser interferometer as applied to plasma diagnostics is reviewed. It is shown that the spherical laser interferometer is capable of nearly two orders of magnitude greater sensitivity than the plane parallel system originally proposed. It has also been shown that one can utilize the high sensitivity of the spherical laser interferometer while preserving the spatial resolution if the plasma is located in the laser cavity. In this application, the plasma changes the laser frequency (within the Doppler-broadened transition) and the reference cavity performs the function of a frequency sensitive reflector. Utilizing this technique, the system has been made 27 times more sensitive than the plane-parallel case while sampling a plasma cross sec-

tion of less than 1 mm². One of the limitations of the laser interferometer was the frequency response. However, it is shown that resonances in excess of 50 per μsec can be detected by sampling the fields in the reference cavity. It is also shown that there is a quantum electronic cross modulation between the coherent laser radiation and the incoherent sidelight emitted by the gas laser system. This fact is demonstrated in the case of an He:Ne system and implies that infrared interferometry can be performed utilizing visible detection equipment. (auth)

13544 (JPRS-39657) METHODS OF HIGH-SPEED MEASUREMENT IN GAS DYNAMICS AND PLASMA PHYSICS. Nesterikhin, Yu. E.; Soloukhin, R. I. Translated from pp 1-127 of Metody Skorostnykh Izmereniy v Gazodinamike i Fizike Plasmy, Novosibirsk, 1965. 95p. (TT-67-30306). CFSTI $3.00 cy, $0.65 mn.

The subject areas of the 10 chapters are as follows: pulse gasdynamic installations, electrodynamic methods of obtaining high-speed plasma flows, methods of high-speed oscillography, mechanical scanning and methods of frame mapping, electronic-optical systems for recording ultrafast processes, methods of visualization and measurement of density, methods of ultrahigh frequencies and optical interferometry of plasma, methods of temperature measurement, measurement of rapidly varying pressures in a continuous medium, and mass spectroscopy and power analysis of plasma. (M.O.W.)

13545 DETERMINATION OF NORMAL TEMPERATURES IN NONTHERMAL PLASMAS. Kelm, Siegfried (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt e. V., Stuttgart). Z. Phys., 199: 261-74(1967). (In German).

The normal temperatures are calculated for an optical thin plasma which is not in local thermodynamic equilibrium. The following cases are investigated: (1) the normal temperatures for spectral lines of neutral atoms; and (2) the normal temperatures for ion lines. Further, there was distinction between lines of which the upper energy levels were higher or lower than the "thermal limit." Formulas for the normal temperatures could be derived for all important cases. The method determining electron temperatures by finding the normal temperatures can now be used also for plasmas which are not in LTE. (auth)

13546 THEORY OF THE ELECTROSTATIC PROBE IN A MODERATELY IONIZED GAS. Su, C. H.; Sonin, Ain A. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 124-6(Jan. 1967).

The collision-dominated theory of the spherical electrostatic probe is extended to moderate degrees of ionization by taking into account the effect of electron–ion collisions. It is shown that, in the limit $R/\lambda_D \to \infty$, the solution of the moderately ionized case can be obtained from that of the weakly ionized case by a simple transformation. (auth)

13547 THE TEMPERATURE DISTRIBUTION IN AN H-MODE rf PLASMA TORCH. Hughes, D. W.; Wooding, E. R. (Univ. Coll. of Wales, Aberystwyth). Phys. Lett., 24A: 70-1(Jan. 2, 1967).

The temperature, electron density and conductivity in the radio-frequency plasma torch have been determined spectroscopically and are compared with earlier measurements. The measured electrical conductivity is also compared with a value calculated from the temperature. (auth)

13548 A CONTRIBUTION TO THE MEASUREMENT OF THE ELECTRON DENSITY OF DISCHARGE PLASMA BY MEANS OF A TOROIDAL RESONATOR. Sicha, M. (Charles Univ., Prague); Pilar, J.; Gajdusek, J.; Novak, Jar.; Fuchs, V.; Lukac, P. Czech. J. Phys., 17: 48-66(1967).

Calculations were made of the relations between the parameters of plasma and a toroidal resonator. The calculations supplement an earlier paper by Sicha (Czech. J. Phys., B12: 632(1962)), where a simplified calculation of the sought relation is given. (auth)

13549 INVESTIGATION OF THE SCATTERING OF LASER LIGHT BY A PLASMA. McMahan, W. H.; Bowen, J. R. (Martin Co., Orlando, Fla.). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 567-79(Sept. 1966).

A new technique is described which enables measurements of the coherent resonance scattering near the center of a line in a high-temperature, pulsed plasma. It is shown how the results of these measurements allows calculation of the population density of various states in the plasma, thus gaining a better insight into the physical properties of the pulsed plasma. Scattering experiments were conducted in which light from a continuous-wave Ar ion laser was coherently scattered by an Ar plasma. The plasma was generated by a toroidal discharge in a theta pinch, operated in the 100-J energy range. Both angular scattering and phase detection techniques were used. The population density of the excited ionic energy levels was a nearly exponential function of the temperature of the plasma and followed the functional relation expected for a level being populated by collisions with Boltzmann equilibrium electrons. The population of this level was measured at greater than 1% of the total number of atoms initially present in the gas. This is explained by the observed predominance of singly ionized Ar spectral lines, and by the metastable behavior of the level. Results showed that atomic and ionic energy level densities in low pressure plasmas can be measured to an accuracy of 25% with a time resolution of about 10 nsec. Thus, the resonance scattering technique presents a valuable tool for the study of transient processes in nonequilibrium, pulsed plasmas. (BBB)

Kinetics of Plasma

Refer also to abstracts 13346, 13428, and 13531.

13550 (AD-639057) NONLINEAR STUDY OF BEAM PLASMA AMPLIFICATION. Poeschel, Robert L. (California Inst. of Tech., Pasadena). Sept. 1966. Contract Nonr-220(50). 123p. (TR-33). CFSTI $3.00 cy, $0.65 mn.

The interaction between an electron beam and the plasma oscillations it excites in traversing a plasma effectively changes the magnitude and direction of the force between beam electrons. The beam behavior is studied theoretically by computing in an exact, nonlinear manner, the trajectories of a disc model electron beam which traverses a linear, dielectric model plasma. The parameters varied are the beam space charge conditions (beam current), the degree of initial velocity modulation, and the ratio of modulation frequency to plasma frequency. Computations show that it is possible to bunch the beam electrons to within 85% of delta-function bunching under some beam and plasma conditions. The electron beam behavior is studied experimentally by observing the beam electron velocity phase distribution with a crossed-field velocity analyzer, and observing the beam current waveform (density-phase distribution) using a wide-band sampling oscilloscope. Experimental results show essentially the same beam behavior as predicted by the computations with some differences which are attributed to variation in the plasma density along the beam path. (auth)

13551 (AD-639210) BEAM/PLASMA INTERACTION WITH TRANSVERSE MODULATON. Abraham, E. E.; Crawford, F. W.; Mills, D. M. (Stanford Univ., Calif. Inst. for Plasma Research). Aug. 1966. Contract DA-28-043-AMC-02041(E). 6p. (SU-IPR-88). CFSTI $3.00 cy, $0.65 mn.

Computations are presented for a finite beam in a finite plasma, indicating that the predicted growth rates for axisymmetric and transverse modulation are generally comparable, and some conclusive observations of growth in the transverse mode are described. Operation in this mode offers a possibility of overcoming the usual coupling difficulties of microwave beam/plasma amplifiers. A novel resonant coupling scheme being studied at Stanford is discussed. (auth)

13552 (AD-641387) INDEX OF REFRACTION OF EXCITED MONATOMIC GASES. Memorandum Report. Rudd, R. A. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). July 1966. 20p. (BRL-MR-1772). CFSTI $3.00 cy, $0.65 mn.

The average polarizability per particle is formulated for an excited monatomic gas. In contrast to the usual procedure of neglecting excited state contributions, a lower bound is obtained considering only atomic excited states. The result shows that for an equilibrium argon plasma previous values of the effective polarizability may be too small by at least a factor of two. (auth)

13553 (AD-641899) THE DYNAMIC SHIELDING RESPONSE OF AN IRRADIATED PLASMA. Scientific Report No. 1. King, J. I. F. (Geophysics Corp. of America, Bedford, Mass.). Feb. 1962. Contract AF 30(602)-2380. 96p. (RADC-TDR-62-48A). CFSTI $3.00 cy, $0.65 mn.

An electromagnetic beam is in general attenuated in traversing a slightly ionized plasma if the plasma frequency, a function of the electron density, is comparable to the frequency of the impressed radiation. A portion of the energy extracted from the beam may cause a local increase in the electron density either through thermal or direct collisional ionization. The altered electron density will in turn affect the beam heating pattern since the absorption coefficient is closely linked to the electron density. This coupling provokes the growth of an electron shield which propagates rapidly toward the radiation source. The shielding response deposits energy progressively upstream and inhibits deep plasma penetration of the beam. A nonlinear one-dimensional model of the Dynamic Shield Response (DSR) is solved analytically assuming the local heating given by the WKB solution of the wave equation. The size, shape, and motion of the electron profile is specified as a function of space and time for a variety of plasma models. (auth)

13554 (AGARD-CP-8(Vol.1), pp 353-84) PLASMA ENERGY TRANSFER TO A SURFACE WITH AND WITHOUT ELECTRIC CURRENT. Eckert, E. R. G.; Pfender, E. (Minnesota Univ., Minneapolis. Heat Transfer Lab.).

Results of heat transfer studies from a hot, dense plasma to a solid surface are compiled and discussed with emphasis on the importance of an electron current from the plasma to such a surface. The energy transfer phenomenon to a surface which does not carry electrical currents is reviewed. Studies are described where electrical currents lead to a significant or even predominant contribution to the observed heat fluxes. Simple energy transfer models are proposed which appear to be helpful, at least for a qualitative description of the observed energy transfer phenomena. (auth)

13555 (AGARD-CP-8(Vol.2), pp 443-71) CORRELATION OF EXPERIMENTAL DATA FOR NONEQUILIBRIUM SEEDED PLASMA. Monti, R. (Naples Univ. (Italy). Istituto di Aerodinamica).

A number of experiments on magnetohydrodynamic plasmas exhibits the expected increase in electrical conductivity due to nonequilibrium conditions set up by a dc electric field. The available experimental data obtained for dc discharges through argon–potassium and argon–cesium plasmas are critically examined and compared with theoretical predictions. In the present correlation no assumptions need to be made for the values of the collision cross sections, and a single value of the energy loss factor is assumed. The only "free" (i.e. "adjustable") parameter is a measure of the optical transparency of the plasma, which it is plausible to consider different in different sets of experiment. It is shown, in addition, that, compared to other existing theories, the subject correlation gives a more satisfactory quantitative agreement throughout a wider range of electrical current densities. (M.O.W.)

13556 (AGARD-CP-8(Vol.2), pp 473-93) DETERMINATION OF TRANSPORT PROPERTIES OF A PLASMA FROM ARC MEASUREMENTS. Schmitz, G.; Patt, H. J. (Technische Hochschule, Aachen (West Germany). Physikalisches Institut (I)).

The various possibilities of determining semi-experimentally the transport properties of a plasma as a function of temperature and pressure from the behavior of electric arcs are investigated. Because there is a quasi-neutral thermal plasma in electric arcs, one can use the basic equations of the single-fluid model of plasma physics for this problem. In the same manner as the transport properties, thermal conductivity, electrical conductivity, specific radiation, viscosity, specific enthalpy and mean mass of the atoms determine uniquely the behavior of the local and integral characteristic quantities of an arc. It must be possible on the other hand to calculate the transport properties from experimental arc data. Methods are presented. The various procedures are applied to nitrogen and argon plasmas. (auth)

13557 (AGARD-CP-8(Vol.2), pp 573-86) DERIVATION OF THE FREQUENCY DEPENDENT ELECTRICAL CONDUCTIVITY OF RELATIVISTIC PLASMAS. Baus, M.; Balescu, R. (Brussels Univ. (Belgium). Faculte des Sciences).

The statistical electrodynamics of relativistic classical plasmas recently developed in the Prigogine School are used to derive a general framework for the study of material coefficients with spatial and frequency dispersion. Starting from the Liouville equation, the conductivity tensor corresponding to the first order response of the plasma to an arbitrary external electromagnetic field, is computed. Next the (known) Vlasov approximation of this tensor is calculated for an isotropic system. (auth)

13558 (AGARD-CP-8(Vol.2), pp 587-618) ELECTROMAGNETIC WAVE PROPAGATION IN A WEAKLY IONIZED PLASMA. Caldirola, P.; De Barbieri, O.; Maroli, C. (Milan Univ. (Italy). Istituto di Scienze Fisiche).

Starting from the Boltzmann equation for the electronic distribution function and using the multiple-time-scale method, recently introduced by Frieman and Sandri, it is possible to obtain a set of equations which describe the interaction processes between an electromagnetic field and a weakly ionized magnetoplasma. Using this technique the expressions of the electronic distribution function and of the complex dielectric permittivity tensor are explicitly calculated. (auth)

13559 (AGARD-CP-8(Vol.2), pp 619-41) INFLUENCE OF IONIZATION NONEQUILIBRIUM ON WAVE PROPAGATION THROUGH PLASMA. de Socio, L.; Napolitano, L. G. (Consiglio Nazionale delle Ricerche, Rome (Italy)).

The propagation characteristics for plane magnetofluiddynamic waves of small amplitude are dealt with in media of finite electrical conductivity, taking into account a finite ionization rate. The model describing the plasma is that for an inviscid mixture with variable ionization degree and negligible thermal conductivity, viscosity and diffusion effects. The general dispersion equation for any relative orientations of the external magnetic field $\underline{B}_0$ and the wave vector $\underline{\lambda}$ is given. For $\underline{B}_0 \parallel \underline{\lambda}$ already known transverse waves of Alfvénic type and longitudinal waves completely analogous to the purely acoustic waves in a reacting mixture are found. The case $\underline{B}_0 \perp \underline{\lambda}$ (longitudinal waves) presents instead new features. Phase velocity and the absorption per unit length are given either in exact form or by a suitable linearization procedure. The influence and the relative importance of the chemical and electrical dissipation on the wave characteristics are discussed. (auth)

13560 (AGARD-CP-8(Vol.2), pp 643-58) ACCELERATION ET REFLEXION DE FAISCEAUX DE PLASMA PAR DES STRUCTURES MIXTES (HF + MAGNETIQUE STATIQUE). (Acceleration and Reflection of Plasma Beams in Mixed Structures (hf + Static)). Bardet, R.; Consoli, T.; Dupas, L.; Geller, R.; Leroy, J.; Parlange, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

Reference is made to the basic principle and the mechanism of the production and reflection of plasma jets. Two types of accelerators are described in particular, measurement methods used are discussed and experimental results are given. The apparatus described functions either with a steady hf field produced by an S-band, 500-W dc generator, or with a dampened traveling-wave hf field, with right circular polarization, produced by an X-band, 300-W dc generator. Fluxes of 2×10^{17} ions/cm^2/sec of 1.2-keV argon have been obtained with the first type of equipment, for 10^{19} ions/cm^2/sec of 200-eV argon with the second; beam diameters were, respectively, 3 cm and 4 mm. In accumulation conditions, the density accumulated in the case of the second apparatus reached the cutting density. The gas yield is more than 30% and the hf energy produced is of the order of 60% (no allowance being made for losses in the guides, window or insulator). A theoretical investigation of the interaction between two plasma beams produced by such structures would seem to indicate that accumulated plasma is not affected by dual beam instabilities. (auth)

13561 (AGARD-CP-8(Vol.2), pp 679-98) MICROWAVE POWERED PLASMA ACCELERATORS. Miller, David B. (General Electric Co., Philadelphia, Pa. Missile and Space Div.).

Steady-state plasma accelerators powered by microwave frequency electric fields are shown to operate efficiently under high-power, steady-state conditions. Details of the experimental studies on a group of microwave driven plasma accelerators are presented. Radio-frequency probing indicated that under the most efficient conditions, the majority of the interaction occurs in a narrow region out beyond the accelerator exit. (auth)

13562 ARL-66-0184) SURVEY OF INVESTIGATIONS OF ELECTRIC ARC INTERACTIONS WITH MAGNETIC AND AERODYNAMIC FIELDS. Myers, T. W.; Roman, W. C. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1966. 115p.

Existing literature related to the interaction of an electric arc at pressure levels of one atmosphere or greater with magnetic fields and/or aerodynamic fields which are transverse to the arc column is discussed. The subject is broken up according to whether or not there is net arc motion with respect to the electrodes. When motion occurs, the arc is designated a traveling arc; this is the type of arc which occurs in rail accelerators, arc heaters utilizing magnetically rotated arcs and electric switchgear circuit breakers. When the arc undergoes no net motion with respect to the electrodes it is designated a stationary arc; this type occurs when the arc is balanced in a transverse gas flow by an appropriate transverse magnetic field. (auth)

13563 (CLM-R-66) THE INTERNAL FIELDS OF $m = \pm 1$ HELICONS IN INDIUM. Facey, T. A.; Harding, G. N. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Sept. 1966. 14p. Dep. mn.

Measurements were made of the radial electric field patterns of standing helicon waves in short cylinders of pure indium at 4.2°K. Agreement with the calculated field patterns was obtained for the modes ($m = 1$, $n = 2$) and ($m = -1$, $n = 2$). It was confirmed that for $m = -1$, the simplest mode propagated is that having $n = 2$, and hence that there is a discrepancy between the theoretical and experimental dispersion relations for this mode. A further investigation of the dispersion relation was made by studying the resonant frequencies of the modes ($m = 1$, $n = 2$) and $m = -1$, $n = 2$) in short cylinders. A comparison of the end effects necessary to obtain agreement between the observed resonances and those calculated on the basis of the theoretical dispersion relations emphasizes the above discrepancy. (auth)

13564 (JPL-TR-32-1018) TWO-DIMENSIONAL UNSTEADY FLOW IN A TRAVELING WAVE PLASMA ACCELERATOR. Peyret, Roger (Jet Propulsion Lab., Pasadena, Calif.). Feb. 1, 1967. 27p.

Two-dimensional unsteady flow in a traveling wave plasma accelerator is studied by means of the small-perturbation theory under the conditions of small magnetic Reynolds number and weak electromagnetic interaction. The partial differential equation which determines the pressure is solved by using a Laplace transform. The other quantities are deduced from the pressure by integration of rather simple equations. Then, the analytical results are numerically computed in order to clarify the effect of different parameters. (auth)

13565 (N-66-28833) [SOLID STATE, APPLIED ELECTROMAGNETICS AND PLASMAS, AND INFORMATION SCIENCES RESEARCH]. Consolidated Semiannual Progress Report No. 3, October 1, 1965-March 31, 1966. (University of Southern California, Los Angeles. Electronic Sciences Lab.). Contracts AF 04(695)-746; AT(11-1)-113; Nonr-228(34). 147p. (NASA-CR-75859). CFSTI $3.00 cy, $0.65 mn.

A summary is presented of research in various areas of solid state physics, applied electromagnetics and plasmas, and information sciences. These studies include: electron probe analysis of semiconductors; electron transport and x-ray production in solids; ferromagnetic resonance in doped YIG crystals; nuclear magnetic resonance in ferromagnetic alloys; defect chemistry of CdS; ionic conductivity in high resistivity CdS; theory of metallic binding; superconducting thin films as microwave circuit elements; wave propagation in bounded, magnetized, hot plasmas; radiation and diffraction of electromagnetic waves; millimeter wave radiometry for radio astronomy; general theory of optimization; optimal control in rendezvous, pursuit and similar two body problems; information processing and signal design theory; coding theory and automata studies; and hybrid and digital computation. Additional research in related areas is discussed, and a bibliography of the research papers generated by these studies is included. (STAR)

13566 (N-66-37206) NUMERICAL STUDIES OF THE NONLINEAR VLASOV EQUATION. Armstrong, Thomas P. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Aug. 1966. 155p. (NASA-CR-78021). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The numerical integration of the initial value problem for the nonlinear Vlasov equation is studied. The Vlasov equation is used to describe the dynamics of a collisionless one-dimensional classical electron gas confined between two perfectly reflecting boundaries. Only long-range Coulomb interactions of the electrons are considered. The numerical results obtained for nonlinear Landau damping compare well with Knorr's results. The results on stable initial conditions show that as the degree of nonlinearity of the initial conditions is increased, the deviation from linear Landau damping appears sooner and is more severe. In some cases damping was observed to cease. Curves showing the time dependence of the damping decrement are derived and compared with predictions of nonlinear theories. New results obtained include the observation that for strongly nonlinear cases, the damping of the electric field causes an initially Maxwellian $f_0(v, 0)$ to develop a peak in the neighborhood of the phase velocity: strong growth of the second harmonic is seen after $f_0(v, t)$ develops such a peak. Also new is the interpretation of the development of a certain class of strongly unstable initial conditions as approaching an inhomogeneous equilibrium. (auth)

13567 (N-66-37298) STUDY OF COAXIAL HALL CURRENT ACCELERATORS AT MODERATE PRESSURES. Hassan, H. A.; Hess, Robert V.; Grossmann, William Jr. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Oct. 1966. 36p. (NASA-TN-D-3286). CFSTI $3.00 cy, $0.65 mn.

A study of coaxial Hall current accelerators at moderate pressures (of the order of 10 mm Hg) and moderate mass flow rates (of the order of 1 g/sec) is presented. The analysis is based on the conservation equations of the plasma constituents and employs a Saha equation with the gas temperature replaced by the electron temperature. The arc voltage is shown to be a linear function of the applied magnetic field strength at constant total current; also, a voltage plateau is reached at the higher currents for a constant magnetic field strength. In addition, for a given total current, magnetic field strength, pressure, and mass flow rate, the theory predicts the electron, ion, and neutral temperatures; degree of ionization; Hall current; and axial and azimuthal mean velocities. Comparison of theory with experiment shows that the theoretical model is in fair agreement with experiment. The influence of ionization rates and three-dimensional effects is discussed. (auth)

13568 (N-66-37319) CORRECTIONS TO THE ASYMPTOTIC HOLTSMARK FORMULA FOR HYDROGEN LINES BROADENED BY ELECTRONS AND IONS IN A PLASMA. Griem, Hans R. (Maryland Univ., College Park). [1966]. 26p. (NASA-CR-78198). CFSTI $3.00 cy, $0.65 mn.

Expressions are given for the electron contribution to the Stark broadening at large distances from the line center, referred to the quasi-static broadening by ions. The electron contribution is calculated with the impact approximation using Lewis or Debye cutoffs, or with the quasi-static approximation. In addition to monopole-dipole interactions causing perturbations within the group of levels having the principal quantum number of the upper state of the line, some allowance is made for monopole-quadrupole interactions, for collision-induced transitions involving changes of principal quantum numbers, and for perturbations of the lower state of the line. Using improved estimates for the relevant atomic matrix elements, the correction factor to the asymptotic Holtsmark result for ion broadening is calculated to an estimated accuracy of 10% for almost all lines of the early hydrogen line series, and estimates are given for higher order terms in the asymptotic expansion and Debye shielding effects. The electron broadening is significant under all practical conditions, even in the validity regime of the impact approximation. (auth)

13569 (N-66-37577) TOPICS IN ELECTRODYNAMICS OF MOVING MEDIA. Final Report, May 1, 1965-May 1, 1966. Tai, C. T.; Pyati, V.; Kalafus, R. M. (Michigan Univ., Ann Arbor. Radiation Lab.). May 1966. 25p. (NASA-CR-78393). CFSTI $3.00 cy, $0.65 mn.

A technical outline of works concerned with the electrodynamics of moving media which have not yet appeared in a technical report or been submitted for publication is given. They include a detailed study of the problem of a small antenna over a moving dielectric media, and a paper concerning the present views on the theory of electrodynamics of moving media. Some of the complexities introduced into the theory by extending it to conducting media are discussed. Several applications are presented which involve the Cherenkov radiation effect. An earlier work on a drifting magneto-ionic plasma is extended to finding the characteristic indices of refraction for some configurations of plasma parameters. The final section deals with the formulation of the time-dependent Green's function for moving lossless media. (auth)

13570 THERMAL RADIATION FIELDS AND ANTENNA PARAMETERS IN MAGNETOPLASMA. Weil, Herschel; Walsh, D. (Univ. of Michigan, Ann Arbor). Radio Sci., 2: 225-39(Feb. 1967).

Spectral densities of components of the electromagnetic fields of thermal radiation in a uniform magnetoplasma are shown to be related to the radiation resistances of electrically small antennas radiating in the magnetoplasma. For antennas of arbitrary size and shape the conventional concepts used to describe antenna performance in isotropic media, i.e., gain, effective area, and effective length are generalized to anisotropic media and relationships between them and radiation resistance established. A thermodynamic method is used in the derivation of the relationships. A new derivation of the radiation resistance for an electrically small dipole in magnetoplasma is given based only on the far-zone radiated fields. (auth)

13571 NOTE ON PLASMA TURBULENCE. Nakayama, Toshio (Univ. of Nagoya, Japan). Phys. Fluids, 10: 247-8(Jan. 1967).

A functional equation for a weak plasma turbulence is solved neglecting the three-point correlation function. Its solution is a generalized Gaussian distribution. The solution for a quasilinear theory is obtained by an assumption similar to Bogoliubov's on nonequilibrium statistical mechanics. (auth)

13572 TURBULENCE OF THE POSITIVE COLUMN IN A LARGE LONGITUDINAL MAGNETIC FIELD. Woehler, Karl-heinz E. (Naval Postgraduate School, Monterey, Calif.). Phys. Fluids, 10: 245-6(Jan. 1967).

At large longitudinal magnetic fields the positive column assumes a turbulent state due to helical instability. The correlation of potential fluctuation and current fluctuation at two probes as a function of the distance and the density profile have been measured. (auth)

13573 POSSIBILITY OF ION-WAVE AMPLIFICATION IN A PLASMA. Schulz, Michael (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 243-5(Jan. 1967).

The ion-acoustic dispersion relation for a two-component plasma, calculated in the presence of intercomponent energy transfer but in the absence of ion-acoustic losses, exhibits amplification in this mode if the election gas is assumed to behave isothermally. (auth)

13574 CONVERGENCE OF SUCCESSIVE APPROXIMATIONS TO THE SCALAR ELECTRIC CONDUCTIVITY OF SOME WEAKLY IONIZED REAL GASES. Schweitzer, S. (Univ. of Pennsylvania,

Philadelphia); Mitchner, M. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 351-3(Feb. 1967).

Approximation equations for the scalar electric conductivity of weakly ionized gases are discussed. In particular, the convergence of these equations is discussed. (M.O.W.)

13575 THRUST FROM AN MPD ARCJET. Hassan, H. A. (North Carolina State Univ., Raleigh). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 338-9(Feb. 1967).

It is shown, without invoking the assumption that an MPD arcjet will operate a minimum potential mode, that there exists a critical mass flow rate at which the thrust is maximum. In the absence of losses, the efficiency at this critical mass flow rate is 50% and, for mass flow rates less (or greater) than the critical mass flow rate, the efficiency is greater (or less) than 50%. (M.O.W.)

13576 KINETIC EQUATION TO HIGHER ORDERS IN THE PLASMA PARAMETER. Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). Phys. Fluids, 10: 127-36(Jan. 1967).

A kinetic equation for a homogeneous electron gas is derived to all orders in the plasma parameter λ (the reciprocal number of electrons per Debye sphere). It has the form $\partial\phi_1/\partial t = \Sigma_{n=1}^{\infty}(e^2)^n (\overline{R}^{(n)} + \overline{\beta}_n - \overline{R}_1^{(n)})$, where $\overline{R}^{(n)}$ is a Fokker–Planck type collision integral that rigorously describes distant collisions between (n + 1) electrons and diverges logarithmically at small impact parameter; $\overline{\beta}_n$ is a Boltzmann-like collision integral for close collisions between (n + 1) electrons and diverges at large impact parameter; and $\overline{R}_n^{(n)}$ accounts for intermediate collisions between (n + 1) electrons and diverges at both large and small impact parameter. Whether or not the various divergent parts of $(\overline{R}^{(n)} + \overline{\beta}_n - \overline{R}_n^{(n)})$ exactly cancel each other out has not yet been proven for all n. The infinite sum, however. is a direct consequence of Liouville's equation and is exact at all t. The first term $(\overline{R}^{(1)} + \overline{\beta}_1 - \overline{R}_1^{(1)})$ has been proven convergent elsewhere. The second-order term $(\overline{R}^{(2)} + \overline{\beta}_2 - \overline{R}_1^{(2)})$, which corresponds to ternary correlations (ternary collisions), is examined in detail and found to have its order of magnitude given by $O(\lambda^2 \log \lambda) + O(\lambda^3)$. (auth)

13577 LANDAU DAMPING AND GROWTH OF ELECTROSTATIC MODES WITH EFFECTS OF SPATIAL VARIATION. Book, David L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 10: 198-203(Jan. 1967).

For a plasma with finite cross section of the sort that occurs typically in laboratory plasma-wave experiments, in a constant magnetic field, the Landau damping (or growth) is obtained by a perturbation procedure in terms of the plasma velocity distribution function and potential and density profiles. The result is applied to the damping associated with the upper and lower branches of the dispersion curve for longitudinal electron plasma waves in the case of a Maxwellian velocity distribution in slab and cylindrical geometries. Application is also made to the growth rates resulting from a low-density electron beam with radially dependent energy superposed on a Maxwellian. (auth)

13578 LOW-FREQUENCY MICROSCOPIC FLUCTUATIONS IN A BOUNDED PLASMA. Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). Phys. Fluids, 10: 204-7(Jan. 1967).

Low-frequency electron density fluctuations of a bounded homogeneous plasma are determined at large wavelengths. It is shown that, when the wavelengths are large, the frequency spectrum of fluctuation is determined by the mean square displacement of an electron in a time interval t, $\langle\Delta(t)^2\rangle$. If a Brownian motion model for $\langle\Delta(t)^2\rangle$ that is exact at large t (as well as at small t) is used, the frequency spectrum can be evaluated by the method of steepest descents. The resulting spectrum is exact at zero frequency and provides a method for local measurements of diffusion coefficients by light scattering or direct probe measurement techniques. The results are valid regardless of the number of particles in a Debye sphere or of the extent of ionization. (auth)

13579 CAUSAL BEHAVIOR OF FORCED PLASMA OSCILLATIONS. Gelman, Harry (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 10: 208-12(Jan. 1967).

The linearized response of a collisionless plasma model to external applied fields is calculated and examined with respect to its causal behavior. It is found that causality is not automatically fulfilled but must be imposed. The Titchmarsh theorem of complex analysis is used as a guide in imposing causality. Alternatively, it is shown that causality can be achieved by adding a damping term to the model and allowing the damping rate, which this term introduces, to approach zero. (auth)

13580 LATITUDE-DEPENDENT PLASMASPHERE OSCILLATIONS. Carovillano, Robert L.; Radoski, Henry R. (Boston Coll., Chestnut Hill, Mass.). Phys. Fluids, 10: 225-9(Jan. 1967).

For a perfectly conducting plasma magnetized by a dipole field, the magnetohydrodynamic toroidal mode describes waves that propagate energy along the field lines. This characteristic causes the resonance oscillations of this mode to be strongly latitude-dependent. The periods of these oscillations are determined for a generalized plasma density of the form $\rho = \rho_0(a/r)^4 D(\vartheta)$ and compared with previously obtained results for the poloidal or isotropic mode. A discussion is provided of the validity of the model plasmasphere and the conditions for experimental observation. (auth)

13581 TRANSVERSE ELECTROMAGNETIC WAVES IN FULLY IONIZED VLASOV PLASMAS. Gibbons, J. J.; Hartle, R. E. (Pennsylvania State Univ., University Park). Phys. Fluids, 10: 189-92(Jan. 1967).

A general class of solutions is obtained for fully ionized plasmas that admit transverse electromagnetic waves with constant phase velocity. The solutions self-consistently satisfy Maxwell's equations and Vlasov's equations for both ions and electrons. It is shown, for plasmas admitting such waves, that the mean velocity in the direction of the propagating wave is equal to the wave speed when the plasma is in a stationary state and is different from the wave speed for nonstationary states. A specific set of ion and electron distribution functions is presented, which admit monochromatic waves. The associated moments and compatibility relations are calculated. (auth)

13582 ENERGY COUPLING AT A TWO-FLUID PLASMA DENSITY DISCONTINUITY. Dunphy, Katherine Haynes; Kahn, David; Mintzer, David (Raytheon Co., Waltham, Mass.). Phys. Fluids, 10: 162-71(Jan. 1967).

The coupling of energy among electron-acoustic, ion-acoustic, and transverse electromagnetic waves at a density discontinuity in a two-fluid ionized plasma is studied by means of the plane wave solutions of the linearized equations of hydrodynamics and Maxwell's equations. An expression for energy conservation in a two-fluid plasma is discussed and applied to energy coupling among the three allowed modes. Numerical results for all types of wave coupling illustrate the influence of the plasma parameters on the efficiency of energy conversion. (auth)

13583 NONLINEAR PLASMA WAVES. I. SECULAR BEHAVIOR OF NONLINEAR EQUATIONS. Freidberg, Jeffrey P. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids, 10: 171-5(Jan. 1967).

A perturbation scheme is devised for investigating the periodic solutions of a nonlinear, second-order, ordinary differential equation with an additional small nonlinear term. It is assumed that when the additional term vanishes the solution to the remaining zeroth-order nonlinear equation is known. When this is the case, explicit expressions for the first-order solution and the first-order correction to the dispersion relation are given in terms of the known zeroth-order solution. (auth)

13584 NONLINEAR PLASMA WAVES. II. NONLINEAR EFFECTS NEAR THE UPPER HYBRID RESONANCE. Freidberg, Jeffrey P. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids, 10: 176-83(Jan. 1967).

The problem of calculating the amount of energy that can be stored in a plasma near the upper hybrid resonance is treated by considering a macroscopic plasma model in which all nonlinear terms are maintained. For frequencies sufficiently close to the hybrid frequency, and for low temperatures, application of the traveling wave hypothesis reduces the macroscopic equations to an ordinary nonlinear differential equation with an additional small nonlinear term. The solution of this equation, by the perturbation procedure described in Pt. I, indicates that nonlinear effects (overtaking and trapping) become more important at lower energy levels as the frequency approaches the hybrid frequency. Explicit expressions are given for the maximum allowable stored energy at hybrid frequency in both a cold and warm plasma. (auth)

13585 MODIFIED QUASI-LINEAR EQUATIONS AND THE APPROACH TO THERMAL EQUILIBRIUM. Harris, E. G. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Contract W-7405-eng-26. Phys. Fluids, 10: 238-9(Jan. 1967). (ORNL-P-2594).

Modified quasi-linear equations have been derived, which predict that the particle velocity distribution function approaches the Maxwell–Boltzmann distribution and the energy distribution of plasma oscillations approaches the Rayleigh–Jeans distribution. (auth)

13586 POTENTIAL DISTRIBUTION IN COLLISIONLESS PLASMAS IN A WEAK MAGNETIC FIELD. Yamasaki, H.; Paik, S. F. (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 10: 239-41(Jan. 1967).

The perturbation of the potential distribution in collisionless plasmas by a weak magnetic field is calculated numerically by

considering the effect of the field on the boundary condition at the insulating wall. (auth)

13587 WAVE–WAVE SCATTERING OF QUASI-LONGITUDINAL WAVES IN MAGNETOACTIVE PLASMAS WITH DIFFERENT ELECTRON AND ION TEMPERATURES. Kropotkin, A. P.; Poustovalov, V. V. (Lebedev Inst. of Physics, Moscow). Phys. Fluids, 10: 241-3(Jan. 1967).

Equations are given for the time history of noise energy spectra due to wave–wave scattering of quasi-longitudinal plasma oscillations for the case of a magnetoactive plasma with different electron and ion temperatures. An example of such a process is presented. (auth)

13588 STATISTICAL PROPERTIES OF COHERENT LIGHT SCATTERED BY A PLASMA. Crosignani, B.; Di Porto, P. (Istituto Superiore Poste e Telecomunicazioni, Rome). Phys. Lett., 24A: 69-70(Jan. 2, 1967).

A method for measuring the correlation functions of a plasma through the statistics of scattered or transmitted light is proposed. The case of second and fourth-order correlation functions is considered. (auth)

13589 RADIATION AND SCATTERING PROBLEMS IN COMPRESSIBLE PLASMAS. PART I. SOLUTIONS BY RAY OPTICS. Felsen, Leopold B.; Labianca, F. M. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Radio Sci., 2: 29-51(Jan. 1967).

Ray-optical concepts are introduced for propagation of electromagnetic and electroacoustic waves in an unbounded compressible plasma, and are then applied to the analysis of radiation in the presence of plane or curved interfaces and obstacles. The method involves tracing of the electromagnetic and acoustic rays through the medium, due account being taken of coupling in source regions, at boundaries, and at scattering centers. The formulas for reflected, refracted, and diffracted fields derived in this manner are verified for special cases by the rigorous treatment in part II, thereby providing confidence in the validity of the procedure. (auth)

13590 RADIATION AND SCATTERING PROBLEMS IN COMPRESSIBLE PLASMAS. PART II. SOLUTIONS OF BOUNDARY-VALUE PROBLEMS. Labianca, F. M.; Felsen, Leopold B. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Radio Sci., 2: 53-71(Jan. 1967).

Different two-dimensional geometries involving bounded, homogeneous, isotropic, compressible plasma regions are considered, and exact integral representations are developed for the electromagnetic and dynamical fields due to various excitations. Specifically, the geometries include plane and cylindrical interfaces, and also a perfectly conducting half plane embedded in the plasma. Asymptotic analysis of the exact solutions by the steepest-descent method leads to results which may be cast into a ray-optical form. It is shown that the geometric-optical and diffraction fields derived in this manner agree with those obtained in part I by direct application of ray-optical procedures. This conclusion lends substance to the validity of the ray-optical method and suggests its utility for even more general configurations which are not readily subjected to rigorous analysis. (auth)

13591 INFLUENCE OF SUPPLY LEAD GEOMETRY OF PLASMA ACCELERATOR ON SHAPE AND VELOCITY OF SHOCK WAVE. Sobra, K.; Kalivoda, L.; Rosenkranz, J. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 91-3(1967).

An investigation was made of an accelerator with parallel conductors, with the supply leads to the electrodes arranged in various ways. The experimental arrangements are briefly described. Measurements are briefly discussed. (M.O.W.)

13592 RADIATION FROM LINEAR RESONANT ANTENNA IN WEAKLY IONIZED PLASMA. Talekar, V. L.; Gupta, R. K. (Malaviya Regional Engineering Coll., Jaipur, India). Int. J. Electron., 21: 443-55(Nov. 1966).

A theoretical study of radiation of electromagnetic and electroacoustic waves in lossy compressible weakly ionized plasma has been made and its dependence on the ratio of source to plasma frequencies has been investigated. A linearized theory is used such that the isotropic electron plasma is regarded as a single fluid continuum. A thin linear resonant antenna is used as the source of radiation and the propagation constant on it is assumed to be the same as in free space. The propagation constant is taken to be complex in plasma for both electromagnetic and electroacoustic waves. Also the effect of electron neutral particle collision is taken into account wherever it is effective. It is shown that propagation is almost unaffected by plasma when source frequencies much higher than the plasma frequency are used. But the effect of plasma on radiation is found to be profound at frequencies smaller than the plasma frequency. General expressions of radiation resistance for both the electromagnetic and electroacoustic waves have been obtained and under these conditions the half-wave dipole is treated as a special case. The results deduced for these are found to be in agreement with those wherever obtained earlier. (auth)

13593 HAMILTON–JACOBI THEORY APPLIED TO VLASOV'S EQUATION. Pfirsch, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Fusion, 6: 301-6(Dec. 1966).

Solutions of Vlasov's equation are given in terms of the Hamilton–Jacobi function S for the characteristics. Such solutions are appropriate in order to derive equations for macroscopic quantities which are of interest, for instance, in turbulence theories. In this context it is important that the Hamilton–Jacobi theory leads to a simple straightforward nonsecular perturbation theory. The method is applied to a one-dimensional plasma which is homogeneous in the unperturbed state. (auth)

13594 SELF-CONSISTENT MAGNETIC FIELD AND INTEGRALS OF PLASMA MOTION. Lacina, J. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 6: 268-75(Dec. 1966).

A general solution of the Vlasov equation for the stationary axisymmetric distribution function of charged particles in plasma, together with a self-consistent solution of the Maxwell equations, is found and physically interpreted. The orthogonal natural system of coordinates of a magnetic field jointly with magnetic induction B and the integrals of motion are first determined. The spatial dependence of the resultant magnetic field is discussed in considerable detail and criteria for the existence of minimum-B are established. It is indicated that currents in plasma itself create configurations with a minimum-B on the axis of symmetry under the following necessary and sufficient exact conditions. (1) There must exist a minimum value of B in the longitudinal direction at $r = z = 0$ (mirror field). (2) It must be, at $r = z = 0$, that $-(4\pi/c)(\partial i_\varphi/\partial r) > \frac{1}{2}\partial^2 B/\partial z^2$, where r, φ, z are the cylindrical coordinates, and i_φ the electric current in the plasma. (auth)

13595 PARTICLE DISTRIBUTION FUNCTION IN PLASMA AND THE SELF-CONSISTENT MAGNETIC FIELD. Lacina, J. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 6: 276-83(Dec. 1966).

The equilibrium configuration of plasma (the stationary,distribution function of charged particles) and of the self-consistent magnetic field is determined on the basis of the first integrals of motion. A detailed analysis is made of the mutual relation between the resultant magnetic field B and the dependence of the distribution function on the integrals of motion; the necessary and sufficient conditions which must be satisfied by the distribution function with a minimum-B field are obtained. For the configuration with a minimum in B on the axis of symmetry, the function $F(p_\varphi)$ must decrease rapidly with increasing p_φ in the vicinity of $p_\varphi = 0$. Accordingly, the number of particles must have a maximum for particles that perform Larmor gyration around the axis ($ep_\varphi < 0$), and the number of particles intersecting the axis ($p_\varphi = 0$) must be non-zero. (auth)

13596 AVERAGED MOTION EQUATION OF CHARGED PARTICLE IN A STATIONARY RANDOM ELECTROMAGNETIC FIELD. Litvak, A. G. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1229-31(1966). (In Russian).

The general solution of the equation of motion in an electromagnetic field of arbitrary configuration is not possible, but an averaging method can be used to give a solution in a slightly inhomogeneous field. The particle motion is represented in the form of a superposition of rapid oscillations $\rho(t)$ (with the frequency of the external field), and of a smooth motion R(t), which is averaged over the period of the field oscillations: $r(t) = R(t) + \rho(t)$. This representation is justified, if the motion is nonrelativistic and the field varies rather smoothly in space. This equation is used to investigate the nonlinear interaction of charged particles with a random electromagnetic field. It is possible to pass from a description of one particle to a description of the behavior of a quasineutral plasma with a dielectric permeability ϵ. The self-focusing of partially coherent wave packets in an isotropic plasma can be examined. In addition, it is of interest to obtain an averaged equation of particle motion in a random field with an arbitrary correlation function. (TTT)

13597 A NOTE ON MODEL KINETIC EQUATIONS. Fidone, I.; Granata, G. (EURATOM-CEA, Fontenay-aux-Roses, France). Phys. Lett., 24A: 175-7(Jan. 30, 1967).

An attempt is made to obtain an explicit expression for the collision constants appearing in the isotropic Fokker–Planck model kinetic equations. (auth)

13598 SCATTERING BY FINITE OBJECTS IN COMPRESSIBLE PLASMA. Tang, C. H. (Raytheon Co., Wayland, Mass.). Nuovo Cimento (10), 46B: 93-112(Nov. 11, 1966).

The problem of scattering by finite objects in the compressible electron gas in the absence of the dc magnetic field is studied from the classical viewpoint. Using a set of linearized plasma equations, the vector field is decomposed into three components, each of which is represented by a scalar potential function. The general solution of the problem is constructed in a straightforward manner. As an illustration, particular attention is paid to the problem of scattering by a plasma column. The general condition for natural oscillations and various scattering formulas are derived. From the general expression, the following types of coupling are exhibited: the coupling between the transverse-type oscillations and the longitudinal-type oscillations, and the coupling between the translational invariant modes and the angularly symmetric modes. Various limiting cases are discussed, and the problem of scattering by conducting cylinders is studied by introducing a conductivity coefficient σ for the plasma column. It is shown that simplified results can be obtained by taking the limit $\sigma \to \infty$. (auth)

Production of Plasma

Refer also to abstract 13347.

13599 (AD-640245) PLASMAS OF MERCURY IN A PRESSURE-DRIVEN SHOCK TUBE. Final Report. Laporte, Otto (Michigan Univ., Ann Arbor. Dept. of Physics). Sept. 1966. Contract AF-AFOSR-934-65. 10p. (AFOSR-66-1939). CFSTI $3.00 cy, $0.65 mn.

A pressure-driven shock tube to produce shock waves in mercury vapor was constructed and is described. In order to have sufficient mercury density it is necessary to heat the entire tube to 400°C. It is intended to make spectroscopic studies of the essential lines of mercury, especially the 2537°A line as emitted by the shock-heated vapor. (auth)

13600 (AGARD-CP-8(Vol.1), pp 215-78) PHYSIQUE DES FAISCEAUX DE PLASMA DE SYNTHESE. (Physics of Beams of Synthetic Plasmas). Bonnal, J. F.; Giacomini, J.; Mainfray, G.; Manus, C.; Morellec, J.; Spiess, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

Research work carried out on synthetic plasma sources and beams is discussed. The discussion is as follows: (1) The electron bombardment ion source; the physical parameters of the plasma are measured and new geometries are suggested for improving the radial distribution of the ion density. (2) The ion beam; the intensity and yields are measured in relation to the parameters of the source. (3) Neutralization of the beam by electron injection; the physical process of neutralization is investigated in detail; the medium obtained is a plasma the general characteristics of which are of particular interest when performing experiments on the physical nature of plasmas. (auth)

13601 (AGARD-CP-8(Vol.1), pp 279-324) SPECTROSCOPIC MEASUREMENTS IN DIRECT ENERGY CONVERSION DEVICES. Wilsted, H. D.; Schneider, R. T.; Woerner, W. (General Motors Corp., Indianapolis, Ind. Allison Div.).

Spectrographic measurements of plasma properties in direct conversion devices and a cesiated helium arc have been made and a summary of these studies is presented. The line reversal technique was used to measure the electron temperature in a magnetoplasmadynamic (MPD) generator and appeared to give good results; accuracies should be within ±75°K. Both the absolute intensity and relative line intensity methods were used to measure electron temperature in a thermionic generator. The absolute line intensity technique was excellent in that it provides a high sensitivity except at near peak line intensity conditions. There are, however, inherent in this method the uncertainties in the accuracy of the transition probabilities. Data scatter in the relative line intensity method made it difficult to use and the accuracy was seriously in doubt. The differential line ratio method developed at the Allison Division of General Motors eliminates the need for transition probabilities, spectral calibration of the photographic plate, and use of a radiation standard. Although it has not been used extensively to date, it can be concluded that it is relatively easy to use and should improve the accuracy of electron temperature measurements. (auth)

13602 (AGARD-CP-8(Vol.2), pp 495-515) EQUATION D'IONISATION DE PLASMAS TRANSPARENTS EN NONEQUILIBRE. (Ionization Equation for Optically Thin Nonequilibrium Plasmas). Bohn, W. L. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt E. V., Stuttgart (West Germany). Institut fuer Plasmadynamik). (In French).

In order to calculate the plasma properties, as well as to evaluate most of the experiments, a knowledge of the plasma components is of outstanding significance. In equilibrium plasmas the components are determined by the Saha equation. For optically thin nonequilibrium plasmas a generalized ionization equation is derived and discussed. With low electron densities, this equation becomes the corona formula, whereas with high electron densities it becomes the Saha equation relative to the electron temperature. Thereby, temperature and ionic charge play a major role. By means of this nonequilibrium equation the components of a helium plasma are investigated with regard to the metastable He I 2^3S level. Furthermore, an estimate has been made of influence of the metastable level on the temperature spectroscopically determined. (auth)

13603 (ORNL-tr-1440) MEASUREMENT OF THE PRESSURE INCREASE IN A HYDROGEN ARC DISCHARGE WITH SUPERIMPOSED AXIAL MAGNETIC FIELD. Doebele, H. F.; Wienecke, R.; Witkowski, S. Translated for Oak Ridge National Lab., Tenn., from Z. Naturforsch., 21a: 390-8(1966). 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

In a cylindrically symmetric hydrogen arc discharge located in an axial magnetic field, pressure is increased in the inner region, where ionization occurs. Measurements were made with initial pressures of 7.5 and 15 torr, with temperatures between 8000 and 12,000°K, and with magnetic inductions of 8.5 and 12.5 kG. A mercury gage was connected to a small opening in the anode to measure the radial pressure distribution in the plasma. Temperatures and electron densities were determined spectroscopically. The Saha equation was found to be applicable in this case. Therefore, experimental results can be compared with theory based on the Saha equation. (auth)

13604 EXPERIMENTAL STUDY OF NORMAL IONIZING SHOCK WAVES. Miller, Bennett (Columbia Univ., New York). Phys. Fluids, 10: 9-16(Jan. 1967).

A coaxial electromagnetic shock tube has been used to study normal ionizing shocks propagating through hydrogen. An experiment is described, which produced plane switch-on ionizing shocks. Quantitative studies were conducted covering the sub-Alfvénic and trans-Alfvénic regimes. Data are presented that support the existence of switch-on fronts in both these regimes, thereby demonstrating the significant effect of the initial electric field on the shock jump conditions. The results are interpreted by appeal to Taussig's theory of normal ionizing shocks. To choose from among the several theoretically predicted ionizing waves propagating at a given speed, Taussig's theory is supplemented by a simple physical criterion modeled on the Chapman–Jouguet hypothesis of Gross and Kunkel. This criterion has strong intuitive support and results in a picture of ionizing shock propagation that is in general agreement with the experimental observations. (auth)

13605 PRECURSOR STUDIES IN AN ELECTROMAGNETICALLY DRIVEN SHOCK TUBE. Lubin, M. J.; Resler, E. L. Jr. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 10: 1-8(Jan. 1967).

Precursor waves have been studied in an electromagnetic shock tube of the T configuration. The precursor velocity, electron density, and current content were determined over a pressure range of 1 to 1000 μ Hg, for electrode discharge voltages of 3 to 17 kV in hydrogen and argon. A longitudinal nanosecond microwave technique was used in conjunction with a semi-infinite microwave cavity measurement to measure the precursor velocity and attendant detailed electron density structure. The current associated with the precursor has been deduced from transverse magnetic-field measurements made with an external pickup coil. The precursor exhibits a definite wave structure with front thicknesses of the order of 2 to 5 cm. (auth)

13606 APPROXIMATE SOLUTIONS TO THE ELECTRON-FLOW EQUATIONS. Radley, D. E.; Birtles, A. B. (Univ. of Sheffield, Eng.). Int. J. Electron., 21: 465-77(Nov. 1966).

Solutions to the electron-flow equations valid near a cathode surface are considered. Sufficient conditions are deduced for the existence of a unique solution given the current density across a cathode, and first-order solutions are obtained which include the effects of applied magnetic fields and relativistic corrections. Application of the results to a computer program for the analysis of electron-flow systems is discussed. (auth)

13607 NEUTRAL INJECTION INTO CLOSED LINE MAGNETIC TRAPS. Bickerton, R. J.; Drogman, D. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 6: 287-92(Dec. 1966).

The build-up of a plasma by fast neutral particle injection into a closed-line magnetic trap is studied. By contrast with the mirror-machine case, the slow plasma formed by charge exchange and ionization is contained within the system. This slow plasma increases the efficiency of fast neutral particle trapping and through 'plasma pumping', lowers the density of slow neutrals. Hence for given initial conditions of equivalent beam

current, base pressure and volume a higher fast ion density can be achieved in a closed-line trap than in an open one. This higher fast ion density is accompanied in most cases by a still larger density of slow plasma. However with a sufficiently intense neutral beam the slow plasma can be heated by energy transfer to temperatures of thermonuclear interest. (auth)

13608 REFLEX DISCHARGES AT LOW PRESSURE. Kucerenko, E. T.; Saenko, V. A. (Kiev State Univ.). Czech. J. Phys., 17: 67-78(1967).

An investigation is made of reflex discharges with cold and hot cathodes at low pressures at which the free path of the electrons exceeds the dimensions of the discharge region. It was found that in the reflex discharge with hot cathode radial deformation of the potential is produced even at weak magnetic fields. The relationship between the anomalous motion of electrons emitted by the cathode and the experimentally determined anomalies of the static and dynamic characteristics of the suppressed reflex discharge was determined. The changes in the linear dimensions of the discharge region were also investigated for all the given forms of discharge. (auth)

Stability of Plasma

Refer also to abstract 13538.

13609 (ORNL-4063, pp 94-110) PLASMA THEORY AND COMPUTATION. Beasley, C. O. Jr.; Budwine, R. E.; Dory, R. A.; Farr, W. M.; Guest, G. E.; Hines, K. C.; Parker, C. E.; Rankin, F. M.; Sigmar, D. J. (Oak Ridge National Lab., Tenn.).

Brief reviews are presented of areas of linear stability theory which are relevant to open-ended magnetic traps and of the present work in nonlinear theories of plasma phenomena. Results from the linear analysis emphasize the importance of magnetic wells and Landau damping: magnetic wells are expected to stabilize all low-frequency modes ($\omega \ll \omega_{ci}$), and Landau damping may stabilize many of the high-frequency velocity-space instabilities. Attention is then focused on those modes not rigorously subject to these two constraints. Some preliminary discussion is given for two such modes, the drift-cyclotron instability and flutelike gyrofrequency modes in plasmas with distinct groups of fast ions intermixed with colder ion populations. Recent progress in the discrimination between convective and nonconvective instabilities adds more emphasis to the necessity of the Landau damping constraint. The review of the present work on nonlinear phenomena summarizes the classes of elementary plasma excitations for which quasi-linear equations have been obtained. The treatment of plasma phenomena in quantum-mechanical formalism is broadened beyond its earlier status. (auth)

13610 BALLOONING OF $\beta = 1$ PLASMAS WITH SHARP BOUNDARIES. Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 10: 236-8(Jan. 1967). (LA-DC-7933).

The stability of a bumpy θ pinch is studied by assuming that the plasma and field are separated by a thin boundary and that the plasma is collisionless. The unstable modes have the largest displacement from equilibrium in the regions of bad surface curvature. (auth)

13611 GEODESIC CURVATURE IN CLOSED PLASMA CONFIGURATIONS. Coppi, B. (IAEA, Trieste, Italy). Nucl. Fusion, 6: 293-6(Dec. 1966).

The stability of a plasma toroidal configuration is affected by the component of the magnetic field curvature that lies within the magnetic surface. The analysis is simplified by introducing an appropriate one-dimensional model. Because the mentioned magnetic curvature component is periodic along the field lines and has a zero average, when the periodicity is shorter than a given amount no instability localized in a particular region along the field can be found. Then the stability analysis is reduced to consider modes that extend along the magnetic field and adapt themselves to the periodicity. Attention is also devoted to modes which arise when there is shear and the periodicity is relatively long. (auth)

13612 QUALITATIVE STABILIZING AND DESTABILIZING EFFECTS IN THE MACROSCOPIC THEORY. Tasso, H.; Schram, P. P. J. M. (Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion, 6: 284-6(Dec. 1966).

In the two-fluid theory for a general static equilibrium without symmetry and with finite β, it is possible to obtain an equation over the velocity field perturbation. This is done by taking into account a stress tensor containing the finite Larmor radius, the viscosity arising from collisions, and the complete Ohm's law. In this equation the space operators, with the exception of the one with the Hall term, have symmetry properties. One can see qualitatively the possible destabilizing effect of the Hall term, the stabilizing effect of the finite ion Larmor radius, the stabilizing and destabilizing effects of the viscosity. (auth)

13613 CONVECTIVE MODES DRIVEN BY DENSITY GRADIENTS. Coppi, B.; Laval, G.; Pellat, R.; Rosenbluth, M. N. (IAEA, Trieste, Italy). Nucl. Fusion, 6: 261-7(Dec. 1966).

The effects of magnetic shear on the drift instability, driven by a density gradient, are investigated. Both the collisional and the collisionless regimes are considered and it is found that in many cases this instability is of convective type, propagating away from the point where $k \cdot B = 0$. Stability conditions are derived, showing that in the collisional regime the amount of shear necessary to stabilize the drift mode is generally less than that required to stabilize the resistive normal mode driven by unfavorable magnetic curvature. Since a less severe condition is instead obtained for the modes driven by a favorable magnetic curvature, an indication in favor of minimum-B toroidal systems is deduced. In the collisionless regimes only moderate amounts of shear are required to completely stabilize the convective density-gradient drift mode. (auth)

13614 CURRENT INSTABILITY IN AN INHOMOGENEOUS PLASMA. Buchel'nikova, N. S.; Salimov, R. A.; Eidel'man, Yu. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Fusion, 6: 255-60(Dec. 1966). (In Russian).

Instabilities in an inhomogeneous strongly ionized potassium plasma during current passage was investigated. The experiments were made with 400 to 2000 Oe magnetic fields and 10^3 to 10^{10} cm^{-3} plasma density in a collisionless regime. It was previously shown that in the absence of the current there is a universal instability manifested by excited drift waves and a diffusion coefficient across the magnetic field about 2 orders higher than classical predictions. The current excites two oscillation modes; one mode of drift waves and the other ion-acoustic waves. In the first mode the oscillation frequency is inversely proportional to the magnetic field, and the waves have an azimuthal component with identical phase velocities for all harmonics. The oscillation frequency of the second mode does not depend on the magnetic field and varies inversely with the longitudinal system. The phase rate of the longitudinal component coincides with the ion-acoustic rate. The critical electron drift rate in relation to the excitation of ion-acoustic waves is $\sim 2 \times 10^6$ cm/sec, or one order lower than the rate computed for a homogeneous, nearly isothermal plasma. With the excitation of current instability the diffusion coefficient rises by a factor of 1.5 to 2.5, moreover, the diffusion increases simultaneously with the increase of oscillation amplitudes. (tr-auth)

13615 QUASILINEAR THEORY OF ION BEAM INSTABILITIES OF LOW-FREQUENCY WAVES IN A PLASMA. Preinhaelter, J.; Vaclavik, J. (Inst. of Plasma Physics, Prague). Phys. Lett., 24A: 167-8(Jan. 30, 1967).

The solution of the quasilinear theory equations is found for the case that low-frequency nonpotential waves with a three-dimensional spectrum are excited by an ion beam in a cold magnetized plasma. The total energy of the excited waves is determined. (auth)

13616 RADIATION BY GROWING PLASMA OSCILLATIONS. Cuperman, S. (Soreq Nuclear Research Center, Yavne, Israel). Phys. Lett., 24A: 170-1(Jan. 30, 1967).

The electromagnetic radiation emitted by growing plasma oscillations from an infinitely long current-carrying cylindrical plasma in vacuum is investigated. It is found that for growing waves with phase velocities smaller than the speed of light, the radiated power density gradually builds up from zero to nonvanishing values. (auth)

Shielding

Refer also to abstracts 13782 and 13898.

13617 NEUTRON ATTENUATION THROUGH IRON LAYER IN LIGHT WATER. Yamaki, Hideo; Fukushima, Yutaka (Hitachi Ltd., Japan). Nippon Genshiryoku Gakkaishi, 8: 474-80 (Sept. 1966). (In Japanese).

The thermal neutron attenuation through iron layers bounded by light water was measured in the HTR experimental pool for six cases in which the iron layers had thickness ranging from 2 to 20 cm. In order to obtain the removal cross section of iron from measurements of neutron flux with and without iron layers, the following corrections were made: geometrical correction of the distance between source and shielding plate to account for the use of the reactor core instead of the fission plate as the neutron source; and correction for the effect of the difference between the incident neutron spectrum on the iron layer and the fission neutron spectrum, obtained from the differrence of mean energy between these spectra and the energy dependence of the total cross section

of iron. With these corrections, the removal cross section of iron was determined to be $\Sigma_r = 0.165 \pm 0.006$ cm^{-1}. This method should be applicable to other cases where a reactor is similarly used for the determination of the removal cross section. The measured cross section of iron layers thinner than 10 cm was about 6% larger than similar layers of 15 ~ 20 cm. (auth)

13618 IMPROVED MONTE-CARLO CALCULATION OF THE NUCLEON–MESON CASCADE IN SHIELDING MATERIAL. II. COMPARISON OF THE RESULTS FOR INCIDENT PROTON BEAMS WITH MOMENTA OF 10 AND 20 GeV/c WITH EXPERIMENTAL DATA. Ranft, J. (CERN, Geneva). Nucl. Instrum. Methods, 48: 261-76(1967).

The Monte-Carlo method for the calculation of the nucleon meson cascade, which was described previously, is applied to incident proton beams with momenta of 10 and 20 GeV/c. The shielding material is steel. The calculated three dimensional star and track densities are discussed and compared with corresponding experimental results. The calculated and measured star and track densities agree very well. The calculated momentum spectra and angular distributions of protons, neutrons, and pions as function of the depth inside the shielding material are presented. The results of cascade calculations for incident proton beams with momenta between 30 and 300 GeV/c are described by some parameters, like buildup factor and attenuation length. (auth)

Solid-State Physics

Refer also to abstracts 13157, 13221, 13263, 13350, 13401, and 13705.

13619 (ORNL–3970, pp 42-4) SOLID-STATE AND MOLECULAR THEORY. Faulkner, J. S. (Oak Ridge National Lab., Tenn.).

Progress has been made in the continuing studies of applications of ligand-field theory, calculations on atoms and molecules, and investigations of the electronic states of disordered systems. In addition, a new program of band-theory calculations has been started. (auth)

13620 (ORNL-TM–1685) PRESSURE DEPENDENCE OF THE ENERGY OF THE RESONANCE GAMMA RAY OF ^{197}Au AND THE HYPERFINE STRUCTURE COUPLING OF ^{197}Au IN THE ORDERED GOLD–MANGANESE ALLOYS. Patterson, D. O.; Roberts, Louis D.; Thomson, J. O.; Levey, R. P. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 114p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Tennessee Univ., [Knoxville].

The pressure dependence of the Mössbauer isomer shift of ^{197}Au was measured at 4.2°K to a pressure of 70.6 kilobars. The shift with respect to metallic gold at zero pressure was fit by the parabola $v_I = 3.78 \times 10^{-3} P - 5.6 \times 10^{-6} P^2$ where v_I is in mm/sec and P is in kilobars. This result is in excellent agreement with that predicted by Roberts et al. The result confirms that in all the gold alloys thus far studied the electronic charge density near the gold nucleus is greater than it is in metallic gold. The hyperfine structure coupling of ^{197}Au in ordered $AuMn_3$, AuMn, Au_2Mn, Au_3Mn, Au_4Mn and solutions containing 0.3 and 1 atomic per cent gold in manganese was measured. The results reflect the crystalline and magnetic structure for the different systems. Values are given for the magnetic field, electric field gradient, and isomer shift for ^{197}Au in the alloys. From the ground-state splitting in Au_2Mn, the value of the magnetic moment of the 77.345-keV excited state of ^{197}Au was determined to be $\mu = 0.420 \pm 0.004$ nuclear magnetons. The hyperfine structure coupling of ^{197}Au in Au_2Mn was also studied at 15.4 and 31.1 kilobars. The isomer shift and magnetic field at the gold nucleus increased with pressure. (auth)

13621 (AERE-Trans–1061) NON-LINEAR ELASTICITY THEORY OF STRAIGHT DISLOCATIONS. Pfleiderer, H.; Seeger, A.; Kroener, E. Translated by H. E. Nowottny (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., 15a: 758-72(1960). 31p. Dep. mn. BIS $0.90. HMSO 4s. 6d.

The stress function method for the solution of internal stress conditions is developed in a general form, on the basis of the Riemann–Cartan dislocation geometry. The practical calculation of plane internal stress conditions in an isotropic medium is represented in detail in terms of the elasticity theory of second order. Simple relationships are obtained for continuous distributions of straight parallel screw or edge dislocations. With the aid of the formulae obtained, the stress fields of single screw and edge dislocations are calculated in quadratic approximation, which lie at the centres of hollow circular cylinders with stress-free edges. As a supplementary result the well-known Zener formula for the mean volume expansion with internal stresses from the quadratic elasticity theory is obtained. (auth)

13622 (AERE-Trans–1062) USE OF THE NON-LINEAR ELASTICITY THEORY FOR DEFECTS IN CRYSTALS. Seeger, A.; Mann, E. Translated by H. E. Nowottny (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., 14a: 154-64(1959). 21p. Dep. mn. BIS $0.70. HMSO 3s. 6d.

Considered from the continuum point of view, defects in crystals can be described as internal stress conditions with singularities (in some cases also as internal stresses in multiply connected bodies). The systematic application of the non-linear elasticity theory to such problems is considered. A description, improved as compared with the normally used linear theory, is obtained for the conditions in the immediate neighborhood of the defects, in which very great strains can occur. Further, it is possible to describe by the non-linear theory some effects which in principle cannot be represented by the linear theory. The formalism of the elasticity theory of second order (which in Hooke's law takes into account the squares of the derivatives of the displacements) is briefly described, and the experimental determination of the elastic constants of higher order, which here occur, is discussed. A special problem of practical importance is treated, i.e., the determination of the dilation, which is important for the small-angle scattering of X-rays and neutrons and also for the scattering of the conduction electrons by defects. The method of calculation used is the perturbation calculation based on the linear solution. The explicit and complete solution for the displacement field of a screw dislocation in an isotropic medium is given. The final example, which is dealt with briefly as a model for an atom incorporated on an interstitial site, is a sphere forced into a spherical shell with equal elastic constants. It is found for both problems that a general formula applies, which was given by Zener, for the change in volume resulting from internal stresses in homogeneous media. (auth)

13623 NUCLEAR MAGNETIC RESONANCE IN URANIUM TETRAFLUORIDE. Saraswati, V.; Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). Indian J. Pure Appl. Phys., 4: 453-6(Dec. 1966).

The magnetic resonance of ^{19}F in polycrystalline UF_4 was observed over the temperature range 78 to 400°K and with magnetic fields 500 to 4000 gauss, using a Varian wide-line NMR spectrometer. The shift is towards higher field with respect to teflon and increases with decreasing temperature. The line shape is markedly asymmetric and the linewidth is strongly temperature dependent. The results are correlated with the susceptibility data. The value of the hyperfine coupling constant and the fractional electron spin (f_s) density at fluorine site were evaluated. (auth)

13624 MOESSBAUER EFFECT STUDY OF ANTIFERROMAGNETIC $FeCl_3$. Kocher, C. W. (Dow Chemical Co., Midland, Mich.). Phys. Lett., 24A: 93-4(Jan. 16, 1967).

The ^{57}Fe Mössbauer effect in polycrystalline anhydrous $FeCl_3$ in the temperature range 6 to 80°K was measured and the typical six-line magnetic splitting below the reported Néel temperature and a discontinuity in the isomer shift at the Néel temperature were observed. (auth)

13625 SOME QUESTIONS CONCERNING THE PASSAGE OF ELECTRONS THROUGH A SOLID. Vyatskin, A. Ya.; Pilyankevich, A. N. (Leningrad Inst. of Precision Mechanics and Optics). Soviet Phys.-Solid State (Engl. Transl.), 8: 2193-4(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2751-4(Sept. 1966).

A theoretical consideration of the experimental data for the passage of electrons with energies of 1 to 10 keV through thin solid films is carried out using retardation in the most general and rigorous form. Energy characteristics are obtained for any material. (auth)

13626 ELECTRON SPIN-LATTICE RELAXATION IN NEUTRON-IRRADIATED QUARTZ AT 37 GHz AND LIQUID-HELIUM TEMPERATURES. Shamfarov, Ya. L. (Inst. of Radiophysics and Electronics, Kharkov). Soviet Phys.-Solid State (Engl. Transl.), 8: 2083-6(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2605-9(Sept. 1966).

Results are given of an experimental temperature-dependence study of the spin-lattice relaxation time T_1 at paramagnetic defects in quartz single crystals subjected to fast-neutron bombardment. Measurements were made at a frequency of 37 GHz over the liquid-helium temperature range of 1.7 to 4.2°K. When these results were compared with results of earlier measurements at 9 GHz, it was apparent that an anomalous relationship existed between the relaxation rate and the constant magnetic field H_0. Instead of the fall in spin-lattice relaxation time as $T_1 \sim H_0^{-4}$ for

one-phonon processes, and the independence of T_1 and H_0 for many-phonon processes, which would be expected from Kronig–Van Vleck theory, the specimen with the lowest spin concentration in fact showed a linear variation as $T_1 \sim H_0$ over the whole temperature region investigated. In the specimen with the highest spin concentration the relationship between T_1 and H_0 varied with temperature from $T_1 \sim H_0^3$ at 1.7°K to $T_1 \sim H_0^{0.5}$ at T = 4.2°K. (auth)

13627 DISTRIBUTION OF IMPLANTED ATOMS AND RADIATION DEFECTS IN THE ION BOMBARDMENT OF SILICON (MONTE CARLO CALCULATION METHOD). Pavlov, P. V.; Tetel'baum, D. I.; Zorin, E. I.; Alekseev, V. I. (Gor'kii State Univ., USSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 2141-6(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2679-87(Sept. 1966).

The results are given of calculation (by the Monte Carlo method) of the distribution of impurity atoms implanted by the bombardment of silicon with boron ions having energies of 20 to 60 keV, and with aluminum, phosphorus, and arsenic ions having energies of 25 to 150 keV. Also calculations were made of the distribution of the radiation defects generated by the bombardment with boron and aluminum ions. The results obtained are analyzed from the point of view of the dependence on the energy and mass of the bombarding ions. The possible consequences of the doping of silicon by the ion-beam method are discussed. (auth)

13628 COMBINATIONAL INVESTIGATION OF NONISOTHERMAL RELAXATION PROCESSES IN ALKALI-HALIDE CRYSTAL PHOSPHORS. Belkina, A. I.; Kalendarev, R. I.; Berdichevskaya, G. Yu. (Inst. of Physics, Riga, USSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 2029-31(Mar. 1967).

Translated from Fiz. Tverd. Tela, 8: 2532-5(Sept. 1966).

A relaxation combination method was developed for the joint investigation of thermally stimulated luminescence, thermal bleaching, photostimulated luminescence, thermally stimulated electron emission, and photostimulated electron emission. The thermally stimulated electron emission was used to determine the sign of nonisothermal relaxation processes. Results are reported for x-irradiated NaCl:Tl, KCl:Ag, and KCl crystals. Possible interpretations of the mechanism of thermal bleaching of color centers are considered. It is concluded that the presence and positions of the thermally stimulated electron emission peaks may indicate clearly a predominantly electron mechanism of a stage in a nonisothermal relaxation process, while the absence of thermally stimulated electron emission may indicate a hole mechanism. (A.G.W.)

13629 POSSIBILITY OF ANISOTROPIC DISORDERING OF fcc A_3B ALLOYS BY IRRADIATION WITH FAST ELECTRONS. Sigmund, P. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 24A: 104-5(Jan. 16, 1967).

Electron irradiation of single-crystal foils of fcc A_3B alloys with similar masses of constituents may produce anisotropy in long-range order. (auth)

13630 RELAXATION DAMPING MAXIMA IN PLASTICALLY DEFORMED MOLYBDENUM AND NIOBIUM SINGLE CRYSTALS. Polotskii, I. G.; Prokopenko, G. I.; Zaporozhets, O. I. (Inst. of Metal Physics, Kiev). Soviet Phys.-Solid State (Engl. Transl.), 8: 2014-15(Feb. 1967).

Translated from Fiz. Tverd. Tela, 8: 2513-14(Aug. 1966).

The temperature dependence of the ultrasonic damping in prestrained single crystals of Mo and Nb was studied in the frequency interval from 5 to 30 Mc. In both materials a temperature of maximum damping was found, which shifted toward higher temperatures with an increase in the vibration frequency. For 3.4% prestrained Mo the maxima were at 173, 183, and 203°K for frequencies of 5, 10, and 30 Mc respectively. For 3.9% prestrained Nb the maxima were at 253, 269, and 298°K for the same frequencies. Annealing of the crystals at 1100°C completely eliminated the damping maxima in both materials. The activation energy was determined from the displacement of the temperature of maximum attenuation at three frequencies. The activation energy was 0.19 eV for Mo and 0.27 eV for Nb. (A.G.W.)

13631 ELECTRICAL PROPERTIES AND ELECTRONIC CONFIGURATION OF THE MONOCARBIDE, MONOPHOSPHIDE, AND MONOSULFIDE OF PLUTONIUM. Kruger, O. L.; Moser, J. B. (Argonne National Lab., Ill.). J. Chem. Phys., 46: 891-900(Feb. 1, 1967).

The electrical properties of PuC, PuP, and PuS were measured over the temperature range of 300 to 1000°K. The monocarbide and monophosphide had resistivities of 257 and 752 $\mu\Omega \cdot$ cm, respectively, at room temperatures; these values did not change appreciably with temperature. Plutonium monocarbide is a p-type conductor with a low absolute thermoelectric power that is only slightly temperature dependent. The monophosphide is also a p-type conductor at room temperature, but it changes to an n-type conductor above 740°K. The quasimetallic conduction of PuC and PuP is essentially proportional to the mobility as indicated by thermoelectric power measurements. Plutonium monosulfide was found to be an intrinsic semiconductor from 425 to 700°K with an activation energy for conduction of 0.240 eV. Calculations show that above 700°K PuS becomes degenerate as the carrier concentration exceeds 10^{19} cm^{-3} and a gradual transition to metallic conductivity is indicated. A peak in the absolute thermoelectric power of 115 $\mu V°K^{-1}$ was observed for this compound, which is an n-type conductor over the temperature range studied. In these plutonium compounds and similar actinide compounds conduction appears to be governed by a systematic change of carrier concentration in the s + d valence band and scattering caused by s + d,f transitions. A split in the f states is proposed as the mechanism responsible for the semiconductor properties of PuS. A comparison was made of the compound unit cell volumes and metal radii for the rare-earth and actinide mononitrides, monophosphides, and monosulfides. The data indicate effective valences for four electrons per atom for the actinide mononitrides and between three and four electrons per atom for the actinide monophosphides and monosulfides. These plutonium compounds do not have much promise as thermoelectric materials because their figures of merit are all too low for acceptable power generation. (auth)

13632 ELECTRON SPIN RESONANCE OF Dy^{3+} IN $LaCl_3$. Brower, K. L.; Stapleton, H. J. (Univ. of Illinois, Urbana). Contract SD-131. J. Chem. Phys., 46: 888-90(Feb. 1, 1967).

The electron spin resonance spectrum of trivalent dysprosium in a single crystal of anhydrous lanthanum trichloride was examined, and weak forbidden resonances were identified as originating from the ground doublet in sites of distorted and essentially undistorted crystal symmetry. Also present in the spectrum is an allowed transition between the energy levels of the first excited doublet. The ESR spectrum due to the ground doublet in an undistorted site can be described by an axially symmetric spin Hamiltonian with $S = \frac{1}{2}$, $g_{\parallel} = 10.43 \pm 0.05$, and $g_{\perp} < 1$. The ESR line from the excited-state transition fits an axially symmetric spin Hamiltonian with $S = \frac{3}{2}$ involving the operators $H_i S_j$, S_j^3, and $H_i S_j^2$; the latter terms are necessary to account for the effects of another doublet 0.135 ± 0.01 cm^{-1} away. This measurement of the zero-field splitting is in good agreement with the optical value of 0.15 cm^{-1}. The remaining parameters of the $S = \frac{3}{2}$ spin Hamiltonian are also in reasonable agreement with values computed from crystal-field theory. (auth)

13633 MEASUREMENTS OF THE LONGITUDINAL SOUND VELOCITY IN AN ARGON SINGLE CRYSTAL AT 76.8°K AND 4.2°K. Gsaenger, M.; Egger, H.; Luescher, E. (Technische Hochschule, Munich). Phys. Lett., 24A: 135-6(Jan. 16, 1967).

The longitudinal sound velocities in the [110]-direction of an argon single crystal were determined to be 1446 ± 7 m/sec at 4.2°K and 1291 ± 6 m/sec at 76.8°K. The quality and orientation of the crystal were directly determined by Bragg scattering of neutrons. (W.D.M.)

13634 FLUCTUATION-DRIVEN SPIN WAVES. Brout, R. (Univ. Libre, Brussels. Univ. of Chicago). Phys. Lett., 24A: 117-18(Jan. 16, 1967).

It is suggested that spin waves exist above the ferromagnetic Curie point for wavelengths short compared to the correlation length of local order. They, therefore, should be readily observable by inelastic neutron scattering for temperatures near critical. An estimate of the frequency is $\omega_q(T) \approx \omega_q(T = 0)/Z$ where $\omega_q(T = 0)$ is the zero temperature frequency and Z the number of spins in the range of force. (auth)

13635 MAGNETIC SUSCEPTIBILITIES AND ^{119}Sn ISOMER SHIFTS OF SOME Pd–Sn ALLOYS. Hayes, M. Cordey; Harris, I. R. (Univ. of Birmingham, Eng.). Phys. Lett., 24A: 80-1 (Jan. 16, 1967).

A correlation between the room-temperature magnetic susceptibilities and ^{119}Sn Mössbauer isomer shifts for a series of palladium–tin alloys is reported. (auth)

13636 ANNEALING OF PROTON RADIATION DAMAGE IN SILICON SOLAR CELLS. Tauke, Regina V.; Faraday, B. J.; Statler, R. L. (Naval Research Lab., Washington, D. C.). Phys. Lett., 24A: 143-4(Jan. 30, 1967).

A thermal annealing study of silicon solar cells irradiated by 4.6-MeV protons at 30°C revealed that the radiation-induced degradation in the photovoltaic parameters was annealed in two stages. The first stage occurs in the range from 50 to 200°C, while the second is observed between 325 and 450°C. (auth)

13637 EXCITED-STATE ABSORPTION IN FLUORESCENT URANIUM, ERBIUM, AND COPPER–TIN GLASSES. Robinson,

Charles C. (American Optical Co., Southbridge, Mass.). J. Opt. Soc. Amer., 57: 4-7(Jan. 1967).

To observe the excited-state absorption in silicate glasses which contain UO_2^{2+}, Er^{3+}, or a copper-tin system, the glasses were excited to a long-lifetime state by pumping with a xenon flashtube. Absorptions from this excited state to higher states were monitored by a second flash. From these data, $\Delta\alpha$, the change of absorbance was calculated. Observations were made for wavelengths between 0.4 μ and 1.1 μ. Strong excited-state absorption bands appeared at 0.537 μ in the UO_2^{2+} ion, and at 0.479 μ in the Er^{3+} ion. In the copper-tin glasses, the effect decreased toward longer wavelengths. (auth)

13638 NEUTRON SCATTERING BY VIRTUAL MAGNON STATE IN Fe WITH Mn IMPURITY. Kroo, N.; Bata, L. (Central Research Inst. for Physics, Budapest). Phys. Lett., 24A: 22-3(Jan. 2, 1967).

The effect of weakly bound magnetic impurity on the spin-wave spectrum is studied in the Fe + Mn system. The energy and width of the virtual level is given. (auth)

13639 ION EMISSION FROM LASER IRRADIATED TUNGSTEN. Bernal G., E.; Ready, J. F.; Levine, L. P. (Honeywell Corp. Research Center, Hopkins, Minn.). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 480-2(Sept. 1966).

The masses, energies, and numbers of ions emitted by a tungsten surface upon irradiation with a laser beam were studied using a time-of-flight spectrometer. For light fluxes of 20 to 70 Mw/cm^2 the ion emission consists primarily of adsorbed species. Ion energies up to 180 eV were measured. From measurements of the thermionic emission current produced by a Q-switched laser with thermal electron velocities in equilibrium with the surface, electron density in the range 10^{14} to 10^{15} cm^{-3} was estimated. It is concluded that inverse Bremsstrahlung can lead to heating of the blowoff material under certain conditions, the most important of which is a high initial electron density; however, for the experimental conditions used the required electron density is too high to allow for this process to proceed. Thus, the picture most consistent with the results for the power densities range of 20 to 70 Mw/cm^2 is that of a slightly ionized gas. The ions and electrons are produced along with a larger number of neutral atoms and molecules. The initial electron densities are too low to lead to plasma heating by the processes described above. (BBB)

13640 ROLE OF ANION AND CATION VACANCIES IN THE FORMATION OF AGGREGATE CENTERS IN SILVER AND THALLIUM ACTIVATED KCl CRYSTALS. Tsal, N. A.; Pashkovskii, M. V.; Didyk, R. I. (Lvov State Univ.). Soviet Phys.-Solid State (Engl. Transl.), 8: 1603-7(Jan. 1967).

Translated from Fiz. Tverd. Tela, 8: 2015-21(July 1966).

The effect of OH^- and Sr^{++} impurities on the formation of silver and thallium aggregate color centers in KCl crystals is investigated. During the additive coloration of KCl-Ag crystals, the anion vacancy excess produced by the OH^- impurity stimulates the formation of silver colloids; strontium addition retards this process. The absorption spectra of these crystals after x irradiation differ strongly from one another in the intensity of the B and E bands. In irradiated KCl-Tl excess anion and cation vacancies have no noticeable effect on the formation of the activator centers. In additive coloration however, hydroxyl ions stimulate the formation of colloidal thallium particles. (auth)

13641 STUDY OF THE BEHAVIOR OF IMPURITY ATOMS IN DIATOMIC CRYSTALS OF InSb AND GaSb. Belozerskii, G. N.; Gusev, I. A.; Nemilov, Yu. A.; Shvedchikov, A. V. Soviet Phys.-Solid State (Engl. Transl.), 8: 1680-3(Jan. 1967).

Translated from Fiz. Tverd. Tela, 8: 2112-16(July 1966).

The behavior of impurity atoms of ^{57}Fe in diatomic crystals of InSb and GaSb has been studied by means of nuclear γ resonance. The absolute values of f, the chemical displacements, and line widths have been measured at various temperatures. For the impurity atom ^{57}Fe in the InSb lattice the interaction forces are harmonic over the whole temperature range investigated. A comparison is made with data for monatomic lattices. The observed values of f for ^{57}Fe in InSb are so large that they cannot be accounted for even on the assumption that ^{57}Fe atoms vibrate only in the optical branches. To explain the observed values of f it is assumed that ^{57}Fe atoms vibrate in discrete frequencies that lie above the optical branches of an ideal lattice. It is shown that the Mössbauer effect for ^{57}Fe in an InSb single crystal has no anisotropy, to an accuracy of 6%. (auth)

13642 RECOVERY OF DEUTERON-IRRADIATED GOLD, ALUMINUM, AND PLATINUM. Herschbach, K. (Douglas Aircraft Co., Santa Monica, Calif.); Jackson, J. J. Phys. Rev., 153: 694-700(Jan. 15, 1967).

A previous paper described the influence of various preirradiation treatments on damage production by deuteron irradiation in gold, aluminum, and platinum. The influence of these treatments on the recovery up to room temperature of gold and aluminum and up to 800°K of platinum is described. In aluminum and gold, except for very small irradiations, both cold work and alloying reduce the amount of recovery in stage I. The damage retained in treated aluminum anneals in stage III, where complete recovery takes place. Cold work reduces and alloying increases the center temperature of stage III in gold. In platinum stage I recovery is increased by quenching, especially for small irradiations; stage III recovery is also increased. The effects of pre-irradiation treatment on radiation annealing and thermal annealing are discussed in terms of the interaction of long-range transport events with lattice defects. Specifically, it is proposed that damage enhancement in quenched platinum is caused by the deflection of dynamic crowdions by atoms relaxed toward single vacancies. (auth)

13643 RADIATION DAMAGE IN Pd PRODUCED BY 1- TO 3-MeV ELECTRONS. Jimenez, C. M. (Air Force Cambridge Research Lab., Bedford, Mass.); Lowe, L. F.; Burke, E. A.; Sherman, C. H. Phys. Rev., 153: 735-40(Jan. 15, 1967).

The change in the residual electrical resistivity of palladium was measured as a function of bombarding electron energy from 1 to 3 MeV. The measurements were compared with several theoretical models for multiple atomic displacements using a weighted least-squares analysis. The results indicate that the degree of fit between the models tested and the data improve as the number of secondary displacements predicted by the model decreases. Using the single-displacement model, the effective threshold for atomic displacement in palladium was found to be 34 ± 2 eV, with a Frenkel resistivity of $(9 \pm 1) \times 10^{-4}$ Ω-cm per unit concentration of defects. (auth)

13644 ENERGY LEVELS OF Sm^{3+} IN LaF_3. Rast, H. E.; Fry, J. L.; Caspers, H. H. (Naval Ordnance Lab., Corona, Calif.). J. Chem. Phys., 46: 1460-6(Feb. 15, 1967).

The fluorescence and infrared absorption spectra of Sm^{3+} in single crystals of LaF_3 were observed and analyzed. Fluorescence was observed in the spectral range of 0.55 to 1.1 μm, and absorption in the region of 0.9 to 10 μm. The intermediate coupling free-ion energy levels of the ^6FH multiplets were calculated from energy matrices including the effects of all the quartet and doublet states of the f^6 configuration. The experimentally determined barycenters of the crystalline Stark components were fitted to a "free-ion" calculation of the energy levels in terms of the Slater integrals F_2, F_4, F_6, and spin-orbit parameter ζ_{4f}. A root-mean-square deviation of 12 cm^{-1} was achieved between the calculated and the observed energies. The wavefunctions are tabulated for Sm^{3+} in LaF_3. Values of F_2 = 356.3 cm^{-1}, F_4 = 55.77 cm^{-1}, F_6 = 4.829 cm^{-1}, and ζ = 1151 cm^{-1} are found to give the best over-all agreement between the observed and the calculated energy levels. (auth)

13645 IRRADIATION-INDUCED COLOR CENTERS IN MAGNESIUM FLUORIDE. Blunt, R. F.; Cohen, M. I. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 153: 1031-? (Jan. 15, 1967).

Color centers, produced by 50-kV x rays, were studied in the rutile-structured MgF_2, largely at room temperature. An initial, slightly anisotropic, absorption band near 260 nm is tentatively identified as due to F centers. Subsequent optical bleaching results in the formation of a strong band at 370 nm and several weak bands, including one at 320 nm. Both of these appear only for $E \perp c$ and are believed to be due to M centers. This choice of models is suggested, in part, by the observation of typical trapped-electron ESR spectra in irradiated samples. Bleaching studies show that the 320-nm band arises from centers lying along the ⟨110⟩ directions, while the 370-nm band seems to be cylindrically symmetric about the c axis. Furthermore, the 320-nm band is reversibly convertible into the 370-nm band. Selection rules have been derived for $(1s)^2 \rightarrow (1s2p)$ transitions in each of the four possible M-center configurations permitted in the rutile structure. It is found that of the two types having F-F bonds in the (001) plane, one identifies rather well with the 370-nm band and the other with the 320-nm band. (auth)

13646 SOME PROPERTIES OF DEFECTS PRODUCED BY IONIZING RADIATION IN KCl BETWEEN 80 AND 300°K. Sonder, E.; Sibley, W. A.; Rowe, J. E.; Nelson, C. M. (Oak Ridge National Lab., Tenn.). Phys. Rev., 153: 1000-8(Jan. 15, 1967). (ORNL-P-2452).

A number of experimental techniques have been combined to study radiation-induced defects that are complementary to F centers. One series of experiments, in which the resistance to dislocation motion due to interstitial centers was monitored by means of flow-stress changes, indicated that the centers produced by irradiation at 80°K and warming in the dark to room

temperature were less effective barriers than were those produced by irradiation above 150°K. In a second series of experiments, measurement of vacancy-center bleaching rates indicated that defects produced by 80°K irradiation and warming to room temperature were much more easily bleached out than were those created by irradiation above 150°K. These results appeared to be correlated with changes in the ultraviolet absorption spectra where, for liquid-nitrogen irradiation and warming, the main absorption band appeared near 228 nm, whereas, for irradiation above 150°K, the main absorption appeared near 190 and 215 nm. The peak of the latter band moved to shorter wavelengths for higher irradiation temperatures. The results may be explained by assuming that interstitial clusters, together with vacancy centers, are produced by ionizing radiation, and that the clusters are of different sizes, depending upon irradiation temperature. There is also some evidence that trace impurities of concentration in the points per million (ppm) range influence the clustering process. (auth)

13647 INFRARED STUDIES OF DEFECT PRODUCTION IN n-TYPE Si: IRRADIATION-TEMPERATURE DEPENDENCE. Whan, R. E.; Vook, F. L. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 153: 814-22 (Jan. 15, 1967). (SC-DC-66-1695).

Infrared absorption measurements of electron-irradiated oxygen-doped n-type silicon are presented. The silicon samples were electron irradiated at carefully controlled irradiation temperatures between 75°K and room temperature. Since the free Si vacancy, and presumably also the free Si interstitial, are mobile at these temperatures, intensity measurements of the vacancy-oxygen center, as well as of newly observed infrared absorption bands, provide a monitor of the intrinsic defect production. For irradiation temperatures below 100°K, semilog plots of the intensities of the absorption bands for identical samples versus the reciprocals of their irradiation temperatures yield straight lines having the form $\alpha = \text{const}\ e^{-\Delta E/\kappa T}$. On the basis of the slopes and intensities of these lines, the absorption bands can be divided into two groups. The more intense group, which includes the 836-cm^{-1} (A-center) band and bands at 922, 932, and 865 cm^{-1}, has a common energy $\Delta E = 0.05 \pm 0.005$ eV. Less intense bands at 936, 945, and 956 cm^{-1} are found to have a common energy $\Delta E' = 0.10 \pm 0.02$ eV. These results are interpreted on the basis of a metastable interstitial-vacancy pair model in which the irradiation-temperature dependence of the formation of the defect-impurity complexes results from the temperature dependence of the production of intrinsic defects. On the basis of this model, the difference in the barriers to liberation and recombination of the metastable pair is 0.05 eV for n-type Si. The more intense infrared bands are concluded to be associated with complexes composed of a single vacancy or a single interstitial trapped at an oxygen impurity atom or group of atoms. Since the energies $\Delta E'$ of the weaker infrared absorption bands are approximately twice those for the strong infrared bands, it is suggested that the weaker bands are associated with complexes composed of two intrinsic defects trapped at an oxygen impurity center. (auth)

13648 ISOTOPE EFFECTS IN THE DIFFUSION AND SOLUBILITY OF HYDROGEN IN NICKEL. Ebisuzaki, Y.; Kass, W. J.; O'Keeffe, M. (Arizona State Univ., Tempe). J. Chem. Phys., 46: 1373-8 (Feb. 15, 1967).

The solubility and diffusivity of hydrogen and deuterium in a single crystal of nickel were measured in the range 490 to 690°K. The theory of isotope effects was developed in the harmonic approximation. It is shown that the experimental results can be quantitatively accounted for in terms of the derived expressions. The theory is tested by calculation of the pre-exponential factor for diffusion (D_0) using only the data for the relative diffusivities of hydrogen and deuterium. The calculated value is in excellent agreement with experiment if it is assumed that direct jumps of hydrogen from one octahedral site to another are involved. (auth)

13649 I. ELECTRON DIFFRACTION. II. THE NATURE OF DEFECTS IN CRYSTALS. Abstracts of Papers Presented at an International Conference, Melbourne, Australia, 16–21 August, 1965. New York, Pergamon Press, 1966. 332p. (CONF-650840).

Published and Distributed for the Australian Academy of Science.

Abstracts are included for 127 of the 133 papers accepted for presentation at the conference. (M.H.R.)

13650 MAGNETISM AND MAGNETIC MATERIALS: 1966 DIGEST. A Survey of the Technical Literature of the Preceeding Year. Haas, C. Warren; Jarrett, H. S. (eds.). New York, Academic Press, 1966. 284p. $11.00.

An outline of the 1965 literature on magnetism and magnetic materials is presented. Related papers are grouped under the following: books and conference proceedings; general theoretical problems; neutron diffraction, spin configurations, and magnetic transitions; properties of transition metals and their alloys; properties of rare earth metals and their alloys; properties of magnetically dilute alloys; properties of nonmetals; electron spin resonance in isostructural compounds; technical properties of soft magnetic materials; magnetically hard materials; thin films; magnetic domains; magnetic materials—chemistry, structure, and crystal; nuclear magnetism; resonance and relaxation; magnetoelastic phenomena; optical phenomena; thermal and transport phenomena; superconductivity; and laboratory techniques and instruments. (J.H.M.)

13651 THE OPTICAL PROPERTIES OF SOLIDS. Course XXXIV of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, June 28–July 10, 1965. Tauc, J. (ed.). New York, Academic Press, 1966. 446p. $22.00.

The intrinsic properties of solids are discussed with particular emphasis on the crystal as a whole—a many-body system with the property of space periodicity. Perturbations such as free electrons and holes, excitons, phonons, and plasmons are also considered. Aspects of the optical properties of solids covered include Coulomb interaction between holes and electrons which give rise to excitonic resonances in the band structure; plasma effects of the conduction electrons in metals and of valence band electrons in other solids; and photon–phonon and photon–electron–phonon interactions. An introduction to the many-body approach to the general theory of optical properties and non-linear optical investigations of solids is presented. (W.D.M.)

Theoretical Physics

Refer also to abstracts 12385 and 13381.

13652 (AD-639651) PAULI ALGEBRA AND THE STRUCTURE OF LORENTZ GROUP. Tisza, Laszlo; Whitney, Cynthia Kolb (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics). 1966. Contract Nonr-3963(24). 43p. CFSTI $3.00 cy, $0.65 mn.

The set of two-by-two complex matrices, called the Pauli algebra, is developed systematically for a variety of applications. In addition to the usual concepts, matrices are discussed which are normal (as a generalization of unitary or Hermitian), the concept of complex matrix axis is introduced, and a so-called polar decomposition for any nonsingular matrix is provided. As a first application, the homogeneous restricted Lorentz group is discussed. The parametrization here advanced for unimodular two-by-two matrices provides directly the geometrical meaning of the Lorentz transformation induced by any such matrix. The discussion is exhaustive and includes matrices which induce the so-called exceptional Lorentz transformations. (auth)

13653 (AD-639733) A COMPUTER SIGNAL PROCESSING APPROACH FOR THE SHAPIRO FOURTH TEST OF THE GENERAL THEORY OF RELATIVITY. Gehrels, Ernst; Kraft, Leon G. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Sept. 2, 1966. Contract AF 19(658)-5167. 31p. (TN-1966-23; ESD-TR-66-431). CFSTI $3.00 cy, $0.65 mn.

I. I. Shapiro has proposed a new test of the general theory of relativity. The test involves the measurement of a discrepancy (of about 30 km) in the measured range of Mercury or Venus as the direct path from the earth to the planet passes through the strong gravitational field of the sun. Such measurements are now made possible by means of modern high-power radars as the Haystack Experimental Facility. Still the signal-to-noise ratios available at superior conjunction preclude sufficiently accurate range measurements by the ranging techniques used to date in radar astronomy. The primary difficulties arise from the Doppler spreading due to planetary rotation and range spreading due to the radar depth of a rough planet. R. Price suggested using measurements made of the planetary range–Doppler profile for comparison in a two-dimensional cross correlation. He showed that such a procedure yields for the power levels available at Haystack, an overall ranging accuracy of better than 1.5 km (9 Msec in round trip travel time), as opposed to a value of 6 km obtainable with an optimum choice of transmitter pulse length and a matched filter receiver. The Fourier analyses required for obtaining a detailed range–Doppler profile require a tremendous amount of computation time. This report describes a table look-up approach that effects a Fourier transform without the use of multiplication. A time saving of at least 10:1 is achieved over a straightforward Fourier analysis. It is thus possible to perform the Fourier analysis and other functions, such as pulse compression analysis (also described in detail) in real time on the computer facilities available on site. (auth)

13654 (AD-641908) COMPLEX RELATIVITY THEORY AND WAVE MECHANICS, (IA). Gleyzal, Andre (Naval Ordnance Lab., White Oak, Md.). Sept. 30, 1966. 47p. (NOLTR-66-189). CFSTI $3.00 cy, $0.65 mn.

An attempt is made to show that a mathematically defined complex gravitational world represents the physical world and provides a unified field theory of relativity. The motion and the de Broglie wave ψ of a complex particle $M = m + ie/\sqrt{\gamma}$ in a world $W(M_0)$, where $M_0 = m_0 + ie_0/\sqrt{\gamma}$ are given. (auth)

13655 ANTI-CORRELATION EFFECTS IN QUANTUM OPTICS. Miller, M. M.; Mishkin, E. A. (Polytechnic Inst. of Brooklyn). Phys. Lett., 24A: 188-9(Jan. 30, 1967).

Specific examples of fields that produce anti-correlation effects are considered. It is shown that for a pure Fock state, the photoelectric counting distribution is binomial, and the counting fluctuations are less than those characteristic of a pure coherent state. (auth)

13656 NOTE ON THE QUANTUM-STATISTICAL BRILLOUIN-WIGNER PERTURBATION THEORY. Erdoes, P.; Jain, K. P. (IBM Zurich Research Lab.). Phys. Lett., 24A: 123-4(Jan. 16, 1967).

The Brillouin-Wigner form of quantum statistical perturbation theory is developed. This gives a better convergence to expansions used to calculate the thermodynamic functions of many-particle systems. The method is demonstrated on the linked-cluster expansion for the free energy of a system of conduction electrons interacting with a magnetic ion. (auth)

13657 SOLUTION OF THE DIRAC EQUATION IN THE FIELD OF TWO BEAMS OF ELECTROMAGNETIC RADIATION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Z. Phys., 200: 13-19(1967).

The solution of the Dirac equation in the field of two directed polarized beams of electromagnetic radiation is obtained. The solution is expressed in a Fourier series of the variables of the incident radiations along with the factor $e^{-(i/\hbar)(p \cdot x)}$, with $(p \cdot p) = m^2 c^2 + (E^2/2)(a^2 + b^2)$. (auth)

13658 THE INVERSE PROBLEM ON SCATTERING DATA FOR A SYSTEM OF DIRAC'S 2n-ORDER EQUATIONS. Gasymov, M. G. Dokl. Akad. Nauk SSSR, 169: 1037-40(1966). (In Russian).

An inverse problem of the scattering theory was resolved for the case in which the matrix function Q(x) possesses properties of the $\begin{pmatrix} 0 & J \\ J^* & 0 \end{pmatrix} \frac{1}{x_n}$ type at zero and at infinity. The matrix J is of the nth order, and all elements are equal to zero except the elements on the second diagonal line which are equal to whole numbers. (R.V.J.)

13659 INTEGRATION OF THE INFINITESIMAL GENERATORS OF THE INHOMOGENEOUS LORENTZ GROUP AND APPLICATION TO THE TRANSFORMATION OF THE WAVE FUNCTION. Moses, H. E. (Massachusetts Inst. of Tech., Lexington). Ann. Phys. (N. Y.), 41: 158-65(Jan. 1967).

The infinitesimal generators of the proper, orthochronous, inhomogeneous Lorentz group are integrated for the nonzero mass case when the infinitesimal generators are given in the Foldy-Shirokov form. The infinitesimal generators are also integrated for the zero mass case when they are given in the Lomont-Moses form. The results are essentially the same as those given by Ritus, but a notation is used which is believed to be more convenient. (auth)

13660 GENERALIZED SURFACE HARMONICS. Moses, H. E. (Massachusetts Inst. of Tech., Lexington). Ann. Phys. (N. Y.), 41: 166-75(Jan. 1967).

Certain functions are introduced which may be considered as generalizations of the usual surface harmonics. They enable one to express in concise form the relation between relativistic wave functions as given in the linear momentum basis and those given in the angular momentum basis for particles of any spin and any mass. Representations of finite rotations about any axis orthogonal to the z axis can also be expressed simply in terms of these generalized surface harmonics. Completeness and orthogonality relations are given for these functions as well as other properties such as expansions of products. The new functions form the basis of a ray representation of the rotation group in a manner similar to that which is formed by the usual surface harmonics. (auth)

13661 GENERAL PERTURBATION METHOD FOR QUANTUM MECHANICAL PROBLEMS. Case, K. M. (Univ. of Michigan, Ann Arbor). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 1-20(1966).

A version of the classical perturbation theory due to Bogoliubov and Mitropolsky is found to be generalizable in a number of directions. Particularly simple is the extension to linear problems of the type encountered in quantum mechanics. The advantages of this method are that: (a) The complete parallelism of classical and quantum mechanical methods is made obvious; and (b) problems conventionally treated by different methods all can be handled by this single technique. (auth)

13662 MOMENT METHODS IN RADIATIVE TRANSFER PROBLEMS. Sherman, M. P. (General Electric Co., Valley Forge, Pa.). J. Quant. Spectros. Radiative Transfer, 7: 89-109 (Jan.-Feb. 1967).

Some of the equations obtained from the radiative transfer equation by use of a moment approximation are unstable. Small changes in the choice of the unknown boundary values give rise to large changes in the solution. The cause of this difficulty is isolated and the problem overcome. The techniques developed give new insight into the moment approximations. The complex boundary conditions derived by Krook for the full-moment approximations have a simple meaning in transformed variables. A comparison is made of the accuracy of full and half-moment approximations using several examples. The first full-moment (Eddington) approximation is found to be roughly comparable to the first half-moment approximation and the second full-moment to the second half-moment approximation. (auth)

13663 NULL ANGULAR ANISOTROPY OF THE GRAVITATIONAL RED SHIFT AT MICROWAVE FREQUENCIES. Horowitz, P.; Pound, R. V. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 24A: 52-3(Jan. 2, 1967).

An experiment to detect an angular anisotropy of the gravitational red shift at 10 Gc is described; and such effect is less than 0.1% of gh/c^2. (auth)

13664 GENERAL RELATIVITY "IN THE DOCK." Stubbs, Peter. New Sci., 33: 326-7(Feb. 9, 1967).

Einstein's theory of gravitation has largely rested on the precise way it explains a peculiarity in the motion of Mercury. New measurements reveal a flattening of the Sun which accounts for part of the effect and undermines the experimental support for general relativity. (auth)

13665 GRAVITATION: CONSTANT OR VARIABLE? Stephenson, L. M. (London Univ.). New Sci., 33: 265-7(Feb. 2, 1967).

An analysis of past experiments shows that there may be an annual variation of the gravitational "constant". A theory to explain this variation which is consistent with one of Einstein's later predictions, but not generally accepted, that all atomic particles are held together solely by gravitational forces, is discussed. (auth)

13666 INFLUENCE OF PAIR-PRODUCTION ON QUANTUM THEORETICAL MEASUREMENTS. Halpern, Otto (American Express Co., Vienna). Acta Phys. Austr., 24: 180-2(1966).

Supplementing results obtained in an earlier paper, it is shown that a calculation by Serber carried out by perturbation theory supports the strong deviations from classical theory which have been shown to be present. (auth)

13667 LINEARITY OF THE LORENTZ TRANSFORMATION. Podlaha, M.; Navratil, E. Acta Phys. Austr., 24: 99-100(1966).

It is shown that the linearity of the Lorentz transformation is the consequence of the axiom of the homogeneity of space-time. Mention is made that in the derivation of the Lorentz transformation in a previous paper the homogeneity was included in the axioms of time dilatation and the principle of relativity. (auth)

13668 THE DIELECTRIC CONSTANT OF BLOCH ELECTRONS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Rajagopal, A. K. (Univ. of California, Riverside). Nuovo Cimento (10), 46B: 46-67(Nov. 11, 1966).

The longitudinal dielectric constant of an interesting Bloch electron gas in crossed electric and magnetic fields is here derived using the effective-mass formulation of Wannier and Fredkin and in the random phase approximation employing an equation-of-motion method. The results are derived for all relative strengths of the electric and magnetic fields. There are some subtleties involved in this problem as the usual Schrödinger equation for the system breaks down for electric fields larger than or equal in magnitude to the magnetic field. Therefore the problem is reformulated by solving the Dirac equation and using the solutions corresponding to spinless particles as the starting point. The effective-mass formulation of the Wannier-Fredkin type is formulated for the Dirac equation so that the problem of crossed fields can be handled more appropriately. From the dielectric constant the optical absorption in solids is derived. The appearance of Landau levels when the magnetic field is stronger than the electric field and the appearance of Wannier-Stark levels in the opposite limit is brought out. In the case of equality of the field

strengths, a new type of Stark levels appears and suggestions are made as to the study of the transition from one type of states to the other as the relative strengths of the fields are varied. (auth)

13669 GRAVITATIONAL THEORY AND OBSERVATION. Dicke, Robert H. (Princeton Univ., N. J.). Phys. Today, 20: 55-8; 60-2; 65-8; 70 (Jan. 1967).

After a brief glimpse of gravitation in its relation to other parts of physics, a balanced theoretical picture of gravitation is presented. A full presentation is made of the observational basis of an understanding of gravitation and it is concluded that they seem to favor the tensor–scalar theory. (W.D.M.)

13670 IS THE de SITTER UNIVERSE RESPONSIBLE FOR MACH'S PRINCIPLE. Inomata, A. (State Univ. of New York, Albany). Nuovo Cimento (10), 46B: 132-3 (Nov. 11, 1966).

The minimal requirement for the de Sitter universe to be responsible for Mach's principle is that the matter containable in the de Sitter geometry must have the property: $T_{\mu\nu} = \varkappa^{-1}(\Lambda - 3K)g_{\mu\nu}$, where $\varkappa$ is the gravitational constant, Λ the gravitational constant, $g_{\mu\nu}$ the geometric tensor of space–time, and $T_{\mu\nu}$ the stress–energy tensor of matter contained in it. It is pointed out that there is a class of Dirac matter that meets this minimal requirement. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 13821.

13671 (DESY–66/34) LABORATORY ANGULAR AND MOMENTUM DISTRIBUTIONS OF PROTONS, KAONS AND PIONS FROM PHOTOPRODUCTION ON HYDROGEN AT ENERGIES UP TO 5.8 GeV. Brall, U.; Erbe, R.; Reimann, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 14p. Dep. mn.

Information on the laboratory angular and momentum distributions of protons, π^+ and π^- mesons and K_1^0 mesons produced by a photon beam with an approximate bremsstrahlung spectrum on hydrogen is presented. The data may be useful for designing secondary pion and kaon beams, for planning experiments and for background estimates at electron accelerators. (auth)

Weak

13672 (AD–639664) MESON AND BARYON SPECTROSCOPY: NEUTRAL CURRENTS IN THE WEAK INTERACTION. Progress Report. Leitner, Jack (Syracuse Univ., N. Y. Dept. of Physics). June 30, 1966. Contract Nonr-669(12). 5p. (NR-022-296). CFSTI $3.00 cy, $0.65 mn.

Progress in experimental studies involving the following topics is briefly summarized: properties of the f*, properties of the K**, measurement of the $K_1^0 - K_2^0$ mass difference via the strangeness oscillation technique, branching ratios of the Y_1^* (1660) hyperon, estimate of the ω^- branching ratios, and study of Ξ^- final states. (auth)

13673 (JINR–P1-3048) PARY $\Lambda\gamma$ I REZONANS $\Lambda\eta$. ($\Lambda\gamma$-Pairs and $\Lambda\eta$-Resonance). Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 46p. (In Russian). Dep. mn.

The uniqueness of the treating of the peak in the $\Lambda\gamma$-mass spectrum (in the interval 1.3–1.4 GeV) as the reflection of the $\Lambda\eta$ resonance is discussed. For this purpose the $\Lambda\gamma$-mass spectra of other possible resonances or other decay modes were calculated. The following conclusions were arrived at: the existence of the $\Lambda\eta$-resonance with the mass slightly above $m_\eta + m_\Lambda$ is the most reliable explanation of the $\Lambda\gamma$-peak; the decays $X \rightarrow \Sigma^0\eta^0 \rightarrow \Lambda^0\gamma\gamma\gamma$ ($m_X \approx m_\Sigma + m_\eta$), $X \rightarrow \Lambda^0\gamma$ ($m_X = 1.425$ GeV), or $Y_1^*(1660) \rightarrow Y_1^*(1385) + \gamma \rightarrow \Lambda^0\pi^0\gamma$ give the $\Lambda\gamma$-mass spectrum not too far from experimentally observed one; and the other possibilities are ruled out, especially all the resonances decaying into $\Lambda\pi^0$. (auth)

13674 (JINR–P1-3098) EKSPERIMENTAL'NOE OPREDELENIE OTNOSITEL'NYKH VEROYATNOSTEI RAZLICHNYKH VETVEI RASPADA K_2^0-MEZONOV. (An Experimental Determination of Relative Probabilities of Various Modes of K_2^0 Decay). Kulyukina, L. A.; Mestvirishvili, A. N.; Nyagu, D.; Petrov, N. I.; Rusakov, V. A.; Wu, Tzun-fan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 24p. (In Russian). Dep. mn.

The relative probabilities of the K_2^0-decays were determined on the basis of treatment of 9400 events from the K_2^0-meson decay registered by means of a magnetic cloud chamber. The probabilities were found to be $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$, $K_2^0 \rightarrow \pi^\pm + \mu^\mp + \nu$, $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$, and $K_2^0 \rightarrow \pi^0 + \pi^0 + \pi^0$. The obtained data within the errors are in good agreement with the $\Delta I = 1/2$ selection rule on isotopic spin. (auth)

Strong (Baryon-Induced)

13675 (AD–639614) PROTON–DEUTERON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS. Coleman, Ernest (Michigan Univ., Ann Arbor. Dept. of Physics). July 1966. Contract Nonr-1224(23). 95p. CFSTI $3.00 cy, $0.65 mn.

An experimental and theoretical investigation of proton-deuteron elastic scattering at high momentum transfers is presented. The differential cross sections for backward elastic scattering at incident proton kinetic energies of 1.0, 1.3, and 1.5 GeV were measured for four-momentum transfer squared (-t) from 2.6 to 5.0 (GeV/c)sq, which corresponds to cosine of center-of-mass proton scattering angles from -0.5 to -0.9. A backward peak is observed, and the slope and magnitude of the peak were determined. At 2.0 GeV for forward elastic differential cross section was measured for -t from 0.44 to 1.54 (GeV/c)sq. A shoulderlike departure from the forward diffraction peak was observed. The one-nucleon exchange peripheral model was successful in interpreting the backward peak. Calculations based on modern three-body quantum mechanical formalisms for the three-nucleon system supporting a two-body bound state also suggest the one-nucleon exchange process as the dominant mechanism. The measured forward differential cross section was explained by the importance of double scattering of the incident proton at higher momentum transfers. A negative value for the ratio of the real part to the imaginary part of the neutron-proton elastic scattering amplitude at 2.0 GeV is shown to yield maximum agreement with the experimental data. (auth)

13676 (ORO-2504-101) A STUDY OF THE LOW ENERGY ELASTIC SCATTERING OF Σ^+ AND Σ^- HYPERONS IN HYDROGEN. Technical Report No. 652. Rubin, Howard A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jan. 1967. Contract AT(40-1)-2504. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The experimental procedure used and results obtained in studying the low momentum (less than ~170 MeV/c corresponding to ~12 MeV kinetic energy) elastic interactions of Σ^+ hyperons with protons are presented. An analysis of the data in the framework of the current theoretical models is also presented. (B.G D.)

Strong (Meson-Induced)

13677 (AD–641991) HIGH ENERGY PHYSICS WITH EMPHASIS ON STRANGE PARTICLES. Final Scientific Report. (Oslo Univ., (Norway). Fysisk Institutt). Sept. 30, 1966. Contract AF-EOAR-95-65. 91p. (AFOSR–66-2606). CFSTI $3.00 cy, $0.65 mn.

A description is given of an investigation of the lambda hyperon production in K^- captures at rest on complex nuclei in a heavy liquid bubble chamber filled with CF3Br. Main emphasis was put on a study of the lambda production in K^- interactions which are not associated with the emission of charged or neutral pions, i.e., possible examples of K^- captures on more than one nucleon. The total rate of lambda emission from K^- captures in CF3 was estimated to (60 plus or minus 3)%. Lower and upper limits for the percentage of lambda hyperons produced in K^- interactions on more than one nucleon were determined to (22 plus or minus 4)% and (40 plus or minus 3)% respectively. It was found that lambda hyperons are rarely produced directly in K^- captures on pair of protons. The results of an investigation on hypernuclei produced by K^- captures in nuclear emulsions are also reported. The reliability of a kinematic analysis method to identify the hypernuclei was examined by applying it to various categories of production and decay stars. (auth)

13678 (IS-T-132) π^+ DEUTERIUM INTERACTIONS AT PION MOMENTUM 6 GeV/c. Judd, Floyd Lymen (Ames Lab., Iowa). Aug. 1966. Contract W-7405-eng-42. 79p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A study has been made of the properties of π^+d interactions at π^+ incident momentum of 6.07 BeV/c. 68,000 pictures were taken and analyzed from an exposure taken at CERN, Switzerland using the 81 cm Saclay Bubble Chamber filled with deuterium and exposed to a π^+ beam from the PS accelerator. The total cross section for π^+d interactions is 52.8 ± 1.6 mb. The 3 and 4 prong events were measured and partial cross sections for final states of pion production are: $\sigma(PP\pi^+\pi^-) = 1.42$ mb, $\sigma(PP\pi^+\pi^-\pi^0) = 1.41$ mb, and for $n > 1$ $\sigma(PP\pi^+\pi^-n\pi^0) = 1.65$ mb. The impulse approximation was found to be valid for over 80 per cent of the events in the reaction $\pi^+ + d \rightarrow p_s + p + \pi^+ + \pi^-$. These events were considered as interactions of π^+ with free neutrons or $\pi^+ + n \rightarrow p + \pi^+ + \pi^-$. This interaction can be considered quite peripheral with over 90 per cent of the scattering in the π^+n rest frame at angles less than 25 degrees ($\cos\theta p > 0.9$). The reaction was investigated for resonance production. No evidence is found for production of N^{*++} resonances. This is consistent with predictions from first order Feynman diagrams for the reaction. The cross section for the production of N^{*0} was difficult to determine because of dipion resonances and the nonresonant production of π^-. Estimated cross section for N^{*0} (1238) is $\sigma(N^*) < 70$ μb and for N^{*0} (1512) is $\sigma(N^*) < 75$ μb. This is consistent with near zero cross sections reported at lower energies. Dipion resonant production is the major feature

of the production process. The known dipion resonances ρ and f^0, are very evident and in addition we have evidence for a new resonance, g. The properties of the dipion resonances found in this experiment are listed. Predictions from the absorption model were applied to the f^0 resonance. The model provides an explanation for discrepancies in the decay angular distribution of f^0. However the model predicts a cross section 5 times greater than the experimental results and the t dependence predicted for the differential cross section is not consistent with the experimental results. (auth)

13679 (UCRL-17230) EXPERIMENTAL DETERMINATION OF THE KΣN PARITY USING A POLARIZED TARGET. Dieterle, Byron D. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1966. Contract W-7405-eng-48. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The KΣN parity was determined using the reaction $\pi^+p \rightarrow K^+\Sigma^+$. A crystal containing polarized protons was used as the target. The counting rates for events produced from protons polarized parallel and antiparallel to $\vec{P}_\Sigma$ were compared, where $\vec{P}_\Sigma$ is the polarization of Σ's produced from unpolarized protons and was previously measured. A higher counting rate was obtained for events for which the protons were polarized parallel to $\vec{P}_\Sigma$, which means that the production amplitude is a scalar. As a scalar amplitude connects states of the same parity, the KΣN parity was obtained: $I_{K\Sigma N} = I_{\pi p} = -1$. This result depends only on the assumptions of spin $\frac{1}{2}$ for the sigma and parity conservation in the reaction. Error estimates give 80 percent probability that the result agrees with an assignment $I_{K\Sigma N} = -1$. The probability for agreement with $I_{K\Sigma N} = +1$ is 2 percent. The result agrees with the usual expectations (as from SU_3) and with a previous experimental determination. (auth)

13680 (UH-511-11) HIGH ENERGY PHYSICS GROUP ANNUAL PROGRESS REPORT, DECEMBER 15, 1965-DECEMBER 15, 1966. Peterson, Vincent Z. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). Jan. 11, 1967. Contract AT-(04-3)-511. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The bubble chamber program discussed includes preliminary results from 3.9-GeV/c π^-p film, bubble-density measurements, and the SLAC beam survey. The spark chamber program includes the $K_2^0 \rightarrow 2\pi^0$ experiment which is in progress, the $K \rightarrow 4e$ experiment in preparation, polarization in the $\pi^- + p \rightarrow \pi^0 + n$; $\eta + n$, and $\pi^- + p \rightarrow \pi^0 + n$ and $\pi^- + p \rightarrow \eta^0 + n$ results. The theoretical work includes axiomatic quantum field theory, η^0 production, the baryon resonance model, octet dominance, SU(6) symmetry, quarks, η' (959) and δ (962) mass degeneracy, and meson (π)-nucleon phase shifts. (J.F.P.)

13681 EVALUATION OF SPIN OF MULTIPION RESONANCE. Azimov, S. A.; Nikishin, B. K.; Rechitskii, I. V.; Chudakov, V. M. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz. SSR, No. 8, 18-21(1966). (In Russian).

The existence of a multipion 0^- resonance with ~3.2 GeV mass was found previously, and the production and resonance decay according to the scheme $\pi^- + p \rightarrow p + n_s\pi^+ + n\pi^0$ (with slow recoil proton and the number of shower particles $n_s = 3$ and 5) at 17 GeV. Investigations are made of 13 π^-p interactions selected according to the residual effective masses and angular distribution characteristics for 11 reactions in which 9 stars have $n_s = 3$ and 4 stars $n_s = 5$. (R.V.J.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 13801 and 13936.

13682 (INR-741/VII/PH) NON-DYNAMICAL INTEGRAL PARITY TESTS. Kozlowski, M.; Werle, J. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 18p. Dep.

Some nondynamical integral tests for the parity of unstable particles are proposed. In the case of fermions they consist in measuring the up-down asymmetry in parity-violating decays of the type $s \rightarrow \frac{1}{2} + 0$. Similar tests can be used in the case of parity-conserving three-particle decays of the type $s \rightarrow \frac{1}{2} + 0 + 0$. The procedure based on the transversality representation is fully relativistic. (auth)

13683 (NYO-1932-116) NEUTRAL VECTOR MESONS AND THE HADRONIC ELECTROMAGNETIC CURRENT. Kroll, N. M. (California Univ., La Jolla, San Diego); Lee, T. D. (Columbia Univ., New York); Zumino, B. (New York Univ., N. Y.). [1966]. Contract AT(30-1)-1932. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The question whether the entire hadronic electromagnetic current operator can be identical with a linear combination of the renormalized field operators for the known neutral vector mesons ρ^0, ϕ^0 and ω^0 is investigated in the context of a Lagrangian field theory. It is found that such an identity is completely consistent with gauge invariance, provided that these mesons are coupled only to conserved currents. The general renormalization problem of the strong interactions of these vector mesons is discussed. It is shown that the proposed identity between the hadronic electromagnetic current and the renormalized meson fields can be related to the possible identity between the unrenormalized currents generating the neutral vector mesons and those generating the photon; furthermore, this proposed identity leads to an exact relation between the entire $0(e^2)$ hadronic contribution to the photon propagator and the renormalized propagators of the neutral vector mesons, and such a relation implies, among other consequences, that to $0(e^2)$ and neglecting leptonic contributions, the ratio of the unrenormalized charge e_0 and the renormalized charge e is finite. Various experimental applications are given. In particular, the analysis on ϕ-ω mixing and their leptonic decay rates is made independently of the approximate validity of the SU_3 symmetry. (auth)

13684 (UCRL-16983) RESONANCES, PARTICLES, AND POLES FROM THE EXPERIMENTER'S POINT OF VIEW. Chew, Geoffrey F. (California Univ., Berkeley. Lawrence Radiation Lab.). July 12, 1966. Contract W-7405-eng-48. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimenters are urged to adopt the particle-pole correspondence in the interpretation of data. The resulting removal of ambiguities in the characterization of unstable particles is stressed. (auth)

13685 ON THE FUNDAMENTAL CONCEPTS IN THE THEORY OF ELEMENTARY PARTICLES. II. PRESENT PROBLEMS. Taketani, Mituo (Rikkyo Univ., Tokyo); Nakamura, Seitaro; Fujimoto, Yoichi; Nagasaki, Masayuki; Furuichi, Susumu; Sato, Shigeo. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 440-50(1966).

A survey is given of fundamental concepts and presents problems in the development of the theory of elementary particles. (L.B.S.)

13686 RELATIVISTIC WAVE EQUATIONS FOR PARTICLES WITH INTERNAL STRUCTURE AND MASS SPECTRUM. Nambu, Yoichiro (Univ. of Chicago). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 368-82(1966).

A class of wave equations that couple an infinite number of tensors or spinors of all ranks is considered. Such a system of equations naturally possesses an infinite number of mass levels, and each eigenfunction implicitly contains a built-in form factor. Two simple examples of first order differential equations are examined. One is based on the set of all finite representations of the Lorentz group, and gives a mass spectrum resembling the hydrogen atom, but probability densities and form factors are unphysical. The other model is based on a unitary representation of the group 0(4,2), and has an inverted hydrogen-like spectrum. The latter corresponds to a generalization of a model first proposed by Majorana. (auth)

13687 GENERAL NONDYNAMICAL FORMALISM FOR REACTIONS WITH PARTICLES OF ARBITRARY SPIN. NUMBER OF FORM FACTORS. PARITY CONSERVATION. Csonka, Paul L.; Moravcsik, Michael J.; Scadron, Michael D. (Univ. of California, Livermore). Ann. Phys. (N. Y.), 41: 1-51(Jan. 1967).

The general nondynamical formalism for reactions involving particles of arbitrary spins, discussed previously, is further developed. The number of form factors in the M-matrix is determined under parity conservation as well as other conservative laws, and from this it is derived that many conservation laws have no nondynamical tests of validity in reactions involving spin-zero particles only. The factorization of the M-matrix into irreducible constituents is developed for parity conserving reactions and it is shown how the compound observable can be written down in terms of observables and so-called pseudo-observables of the constituent reactions. It is then demonstrated that for parity-conserving reactions, an unpolarized and uncorrelated particle is in general equivalent to a fictitious spin-zero particle possessing both positive and negative parity (dual particle). The structure of observables in terms of the type of traces they contain is studied. The number of terms in a compound observable is derived. It is shown that the number of observables is a parity-conserving reaction is always larger than the number of independent bilinear combinations of form factors. Thus, there are always linear relations among the observables. The number and character of these relations is explored and it is shown that they also lead to the com-

plete list of parity experiments, i.e., experiments from which we can determine the intrinsic parity of one of the particles in the reaction, knowing the intrinsic parities of the other participating reactions but knowing nothing about the dynamics of the reaction. It is shown that the observables can be divided into subclasses, a given subclass containing observables which are different linear combinations of the same bilinear combinations of form factors. Each such bilinear combination appears in one and only one subclass. (auth)

13688 POSITION OPERATOR AND LOCALIZATION FOR PARTICLES OF VANISHING REST MASS. Langbein, Werner (Univ., Wuerzburg, Ger.). Z. Phys., 198: 304-14(1967). (In German).

The construction of position operators for particles of vanishing rest mass is possible without difficulty, if only the requirements of Hermiticity as well as the correct transformation behavior of the spatial rotation and translation are considered. This allows, for each helicity, a position operator to be specified whose components are not commuted but which allows any good spatial localization of the particles. (tr-auth)

13689 PROCEEDINGS OF THE CONFERENCE ON THE MATHEMATICAL THEORY OF ELEMENTARY PARTICLES HELD IN DEDHAM, MASSACHUSETTS, SEPTEMBER 12–15, 1965. Goodman, Roe; Segal, Irving (eds.). Cambridge, Mass., Massachusetts Institute of Technology, 1966. 193p. $6.00. (CONF-650984).

The discussion of the mathematical theory of elementary particles includes seven types of U(6), applications of algebraic topology to physics, parafield theory, existence theorems for a cut-off $\lambda\phi^4$ field theory, holomorphy envelope calculation, quartic interaction in two dimensions, field-theory-like axiom system, and quantization and dispersion for nonlinear relativistic equations. Also covered are spontaneous symmetry breakdown, a method for Euclidean quantum field theory, infraparticle structure and functional integrals, the structure of finite parts in renormalizable quantum field theories, and the state of the art in the quantum theory of elementary particles. (J.F.P.)

Electromagnetic

13690 (NP-16545) NESOKHRANENIE VEKTORNOGO TOKA I MINIMAL'NOST ELEKTROMAGNITNOGO VZAIMODEISTVIYA. (Non-Conservation of Vector Current and Minimum of Electromagnetic Interaction). Terent'ev, M. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 20p. Dep. mn.

Some consequences of the relation $\partial_\mu j_\mu^{(s)} = \pm ieA_\mu j_\mu^{(s)}$ which expresses the "minimality" of the charge vector current nonconservation are considered. The connection between some combination of the β-decay form factors and of the virtual Compton effect amplitude is obtained. Also obtained is the connection between some amplitudes of weak processes with simultaneous emission of γ quantum. (auth)

13691 ELECTROMAGNETIC MASS DIFFERENCE AND THE STRUCTURE OF BARYON AND BOSON. Minamikawa, Toshiyuki (Tokyo Univ. of Education); Miura, Kimio; Miyamoto, Yoneji; Arafune, Jiro; Iwasaki, Yoichi. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 56-66(1966).

Electromagnetic mass difference of baryon and boson is discussed on fundamental triplet model, taking into account the electromagnetic self energy of fundamental triplet (Δm), Coulomb force and magnetic hyperfine interaction between triplets. Electromagnetic mass difference is successfully explained by taking $\Delta m = -1.9$ MeV for baryon ($\Delta m = -7$ MeV for boson), the mean separation $\langle r \rangle = 0.4 \times 10^{13}$ cm between triplets, and the anomalous magnetic moment of triple: $\mu = 2.6\ e/2M_p$. Baryons and bosons are described by 56 and 35 representation of SU(6). In this electromagnetic mass difference $K^+ - K^0$ is easily explained by the electromagnetic mass difference of fundamental triplet, while this cannot be explained from the conventional field theory, where K meson is assumed to be elementary. The electromagnetic mass difference $\pi^+ - \pi^0$ is due to Coulomb force and hyperfine interaction between triplet and antitriplet. The electromagnetic mass difference of boson is also discussed from the model where bosons are compound state of baryon and antibaryon, but this model is found to be implausible. (auth)

13692 DEUTERON POLARIZATION AND NEUTRON FORM FACTORS. Umerjee, R. K. (Texas A and M Univ., College Station). Nuovo Cimento (10), 46B: 68-77(Nov. 11, 1966).

The spin state of the deuteron following elastic scattering of electrons is studied in impulse approximation through the one-photon exchange. It is found that a measurement of the deuteron polarization in the final state can be used to evaluate the form factors of the neutron with some advantage. It is also shown that inclusion of the D-state of the deuteron does not substantially change our results. (auth)

Weak

Refer also to abstract 13661.

13693 ANOMALOUS INTERACTIONS OF HIGH-ENERGY MUONS. Kitamura, Takashi; Sugano, Reiji (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1014-22(Nov. 1966).

If the cosmic-ray data on penetrating showers with large ransferred energies produced by high-energy muons are accepted, the muon would have anomalous interactions other than the electromagnetic one. The hypothesis of a new neutral (vector) boson χ with a mass of $\sim 10\ m_N$ is convenient to explain the penetrating showers and is not inconsistent with the muon-pair and muon-bundle production by energetic cosmic muons. The possible existence of a quadratic strong interaction of the intermediate weak boson W is also discussed in connection with these phenomena. (auth)

13694 PARITY VIOLATING AMPLITUDES FOR NONLEPTONIC HYPERON DECAYS. Koyama, Hideyuki; Tamiya, Takanori (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1044-53 (Nov. 1966).

From a product of modified Cabibbo currents which effectively involves the breakdown of SU(3) symmetry, the parity-violating (p,v) amplitudes for nonleptonic hyperon decays are derived in a pole dominance model with the four-fermion type of weak interaction. It is shown that the relative values of the amplitudes are consistent with experiment and the relation $A(\Sigma_+^+) \approx 0$ is caused by the fact that the ratio d/f is nearly equal to $\sqrt{3}$ in the weak as well as the strong interactions. The parity-conserving amplitudes are also discussed on the assumption of octet dominance on the basis of our results on the p,v. decays and general investigations of recent experimental work. (auth)

13695 STRUCTURE OF WEAK INTERACTIONS. Tanikawa, Yasutaka (Kobe Univ., Japan); Nakamura, Seitaro. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 306-14(1966).

The structure of weak interaction is investigated as that resulting from the intermediate boson theory proposed by Tanikawa and Watanabe. It gives a theoretical framework in which the chirality conserving weak interactions have justification. Some consequences inferred from the theory are compared with the high energy neutrino experiments. (auth)

13696 DYNAMICAL APPROACH TO WEAK INTERACTIONS. Nishijima, Kazuhiko (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 392-404(1966).

The theory of weak interactions based on unsubtracted dispersion relations for weak-interaction form factors is reviewed, and it is further developed. A new approach to the nonleptonic decay of hyperons is presented and compared with experiment. The agreement is satisfactory, and it is also shown that the theory is capable of explaining the origin of the current algebra as well as a possible mechanism of CP violation without reference to the fictitious quarks. (auth)

Strong (General)

Refer also to abstract 13706.

13697 (DESY-66/35) ON HIGH ENERGY MULTIPARTICLE PRODUCTION AND ELASTIC SCATTERING PROCESSES. Satz, H.; van Keuk, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 23p. Dep. mn.

For many-particle production a model which assumes at fixed impact parameter a statistical picture of fireball formation and decay is studied. In this way one obtains on one hand for the usual statistical model an extension which includes angular momentum conservation and allows predictions for all inelastic and corresponding absorptive elastic cross-sections, on the other a central collision counterpart of the peripheral model. The asymptotic predictions for production processes are discussed and compared to those of the usual statistical model and of the multiperipheral model. The resulting form for elastic and total cross-sections, obtained by unitarity, agrees with that given by Van Hove's uncorrelated particle model. (auth)

13698 (N-66-37560) TWO-TEMPERATURE STATISTICAL MODEL FOR PARTICLE PRODUCTION AT HIGH ENERGIES. Wayland, J. R.; Bowen, T. (Arizona Univ., Tucson. Dept. of Physics). July 21, 1966. 24p. (NASA-CR-78380). CFSTI $3.00 cy, $0.65 mn.

With the assumption of two characteristic temperatures, one associated with the transverse momentum distribution, the other with the longitudinal, the differential cross section, $d^3N/dpd\Omega$, is calculated from the relativistic quantum statistical mechanical number density. Good agreement with experimental data for pions, kaons, and antiprotons is obtained by the fitting of T_0, the transverse temperature, T, the longitudinal temperature, and V_0, the interaction volume. The model is related to a simple physical interpretation. (auth)

13699 RELATION BETWEEN CHARGE-EXCHANGE AND QUASI-ELASTIC SCATTERING AND DYNAMICS OF MULTIPLE MESON PRODUCTION IN HIGH ENERGY REGION. Fukuda, Hiroshi; Iso, Chikashi (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 255-74(1966).

The relation between angular distribution and energy dependence of A + B → C + D type scattering cross section and dynamical behaviors of multiple-meson wave produced in high-energy collision is analyzed through unitarity relation. Assuming that the most energetic particle in inelastic channel has the same quantum number as that of the incident particle in the same direction, the various behaviors of quantum-number exchange scattering can be explained semi-quantitatively, i.e., energy dependence and angular distribution of $\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, $pp \to pN_\xi^*$, $\bar{p}p \to \bar{\Sigma}^-\Sigma^-$ etc., as well as elastic scattering. Also under the above assumption a factorization theorem can be shown for energy dependence and angular distribution of A + B → C + D type scattering; this theorem is very useful to compare various two body processes. The results are different in some processes from that deduced by Reggepole theorem. (auth)

13700 TESTS OF MODELS OF ELEMENTARY PARTICLES. Okubo, Susumu (IAEA, Trieste, Italy). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 114-40(1966).

By means of the algebra of currents, the validity of models of elementary particles were tested. From studies of the decay rate of $\pi_0 \to 2\gamma$, a calculation of the axial vector renormalization constant g_A, the decay rates of $V_9 \to 1 + \bar{1}$ and those of $V_9 \to P_8 + \gamma$ decays, it has been concluded that the fractionally charged quark model of Gell-Mann and Zweig is the best candidate among all others. (auth)

13701 SPACE-TIME DISTRIBUTION OF HEAVY PENETRATING PARTICLES (QUARKS) IN EXTENSIVE AIR SHOWERS. Bjoerneboe, Jens; Koba, Ziro (Univ. of Copenhagen). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 192-210(1966).

The space-time distribution of heavy penetrating particles (possibly including quarks), produced in extensive air showers and arriving at a lower level, is investigated in an analytical way taking into account fluctuations in the position and the dynamical characteristics of the creation and successive interactions. On plausible simplifying assumptions the scale transformation properties of the distribution are discussed and applied to the integration over the spectrum of the primary particles. Effects of the fluctuations in transverse momenta can be separated out. The distribution function is worked out in a "linear approximation" and some physical aspects of the obtained results are discussed. (auth)

13702 A FIELD THEORY OF ELEMENTARY PARTICLES WITH S_3 INVARIANCE. Katayama, Yasuhisa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 338-49(1966).

A field theory of elementary particles is presented and examined with the following assumptions: (I) There are three basic fermion fields. (II) Three fields are described by nonlinear equations with symmetry of their permutation. (III) They obey a regularized quantization with a single constant. The 0-nonet meson and ½-octet baryon are assumed as the composite systems of three basic fields. Their mass eigenvalues and the effective coupling constants are calculated. The results are (i) the coupling constants of nonlinear terms with V-A form $l_8^1 = 0.31\ (4\pi/\kappa)^2$, $l_1^1 = 0.06\ (4\pi/\kappa)^2$, and $l_8^1 = 0$, (ii) 0-meson masses μ_π, μ_K (fixed), $\mu_\eta = 0.62\ \kappa$ and $\mu_X = 1.04\ \kappa$, (iii) ½-baryon masses $\kappa_N = \kappa$ (fixed), $\kappa_\Lambda = 1.05\ \kappa$, $\kappa_\Sigma = 1.06\ \kappa$ and $\mu_\Xi = 1.07\ \kappa$, and (iv) the effective coupling constants $g^2_{NN\pi}/4\pi = 12.4$, $g^2_{NNn}/4\pi = 3 \times 11.0$, $g^2_{NNX}/4\pi = 6 \times 5.8$, and $0 \le g^2_{N\Xi K}/4\pi \le 11.3$, $0 \le g^2_{NAK}/4\pi \le 3 \times 11.3$ and others, showing the purely F-coupling features. (auth)

13703 POSSIBLE C-NONCONSERVING INTERACTIONS AND MODELS OF ELEMENTARY PARTICLES. Maki, Ziro; Umemura, Isao (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 573-84(1966).

A systematic survey is made on the possible forms of C-noninvariant interactions of local trilinear type under which hypothetical bosons couple to the bilinear sources of fundamental fields of spin ½ (urbaryons) for hadrons. By examining the necessary conditions to be imposed on such an interaction for giving actual effects of C-nonconservation in the hadronic processes, it is shown that the interactions should either contain derivative type or else include the exchange type of sources with appropriate phase differences. The latter type of interactions, which cannot be applied to the single triplet or the L-type quartet models, have, in general, to be reinforced by a symmetry-breaking strong interaction that induces the transition between different kinds of urbaryons in each of the models of hadrons. (auth)

13704 PICTURE OF STRONG AND SUPER-STRONG INTERACTIONS. Tati, Takao (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 153-62(1966).

An argument is presented about a picture in which the super-strong interaction constructing hadrons and the strong interactions between hadrons are derived in a unifying way from a fundamental interaction between basic particles. A characteristic feature is that it leads to the super-strong potential between basic particles, being square-well-like (rather than Yukawa-like) with a range considerably larger than their Compton wavelength, owing to their many-body-system-like structures induced by the super-strong interaction. (auth)

13705 THE BOSE–EINSTEIN CONDENSATION OF SYMMETRY MULTIPLETS IN ASYMMETRIC GROUND STATES. Umezawa, Hiroomi (Univ. of Wisconsin, Milwaukee). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 585-93(1966).

The nature of asymmetric ground states in invariant theories is discussed for the cases in which Coulomb-type interactions are absent from the original equations of interacting fields. It is pointed out that such ground states can be created only by the Bose–Einstein condensation of bosons, the energy spectra of which are gapless. The latter bosons obtain certain symmetry quantum numbers in course of the dynamical rearrangement of symmetries. The Bose–Einstein condensation gives rise to a set of dynamical spurions. The considerations are shown to provide a good qualitative picture of the behavior of systems with asymmetric ground states. (auth)

Strong (Baryon No. = 0)

13706 QUARK–ANTIQUARK–MESON INTERACTIONS AND THE SU(6) SYMMETRY. Kanazawa, Akira (Hokkaido Univ., Sapporo); Sakuma, Tetsuo. Progr. Theoret. Phys. (Kyoto), 36: 1078-80(Nov. 1966).

The idea of self-consistent bootstrapping is applied to the quark–antiquark–meson system, where the mesons are considered as the composite states of quark–antiquark pairs in the SU(3) invariant way. It is shown that the self-consistency requirement yields uniquely the apparent SU(6) symmetry in the static limit. (L.B.S.)

13707 BOSON RESONANCES AND NUCLEON–ANTINUCLEON ANNIHILATION. Minami, Shigeo (Osaka City Univ.); Tanabe, Kosai. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 175-82(1966).

Using a model for nucleon-antinucleon annihilation the relative magnitude of the reaction amplitudes for the $N + \bar{N} \to 5\pi$ process is estimated from consideration about charge space, and both the angular distribution and the energy dependence of the $N + \bar{N} \to \pi + \pi + V$ (vector meson) reaction at low energies are predicted from a field theoretical point of view. (auth)

13708 SYSTEMATICS AND PHENOMENOLOGY OF MESON FAMILY. Iizuka, Jugoro (Kanazawa Univ., Japan). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 21-34(1966).

Previous studies on a systematics and phenomenology of meson family are reviewed and extended based on the intuitive pictures. In these discussions, the triplet configurations of hadrons are extensively used, from which the meaning of the selection principle is made clear. This principle is applied to the meson-baryon vertices. An indirect test of both the ur-baryon models and the non-relativistic descriptions of meson nonets is further suggested, where the E1-transitions, $1^+ - 9 \to 1^- - 9 + \gamma$, are taken as the test processes. (auth)

13709 EVIDENCE FOR PARITY-SU(3) MIXING IN DECAYS OF MESON RESONANCES. Moran, W. P.; Marshak, R. E. (Univ. of Rochester, N. Y.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 405-32(1966). (UR-875-157).

The predictions of the $\overline{W}_3$ (or $S\overline{W}_3$) theory for the strong decays of meson resonances are investigated. The effects of mixing of the parity P and the internal U_3 (or SU_3) symmetry contained in the $\overline{W}_3$ (or $S\overline{W}_3$) group, which implies a mixing of the charge conjugation C with the U_3 (or SU_3) group, are considered for two-particle decays. The formulas obtained are then applied to two-particle meson decays (for $J = 0^+, 1^+, 2^+$) and comparison is made with experiment. Some tentative conclusions on the broken $\overline{W}_3$ ($S\overline{W}_3$) symmetry are presented. (L.B.S.)

Strong (Baryon No. = 1)

13710 BACKWARD PEAK IN PION–NUCLEON SCATTERING AND COMPOSITE STRUCTURE OF THE PION. Imachi, Masahiro (Nagoya Univ., Japan); Otsuki, Shoichiro; Sakai, Kenji; Yasuno, Masaru. Progr. Theoret. Phys. (Kyoto), 36: 1023-34 (Nov. 1966).

In order to investigate the dynamical structure of the pion, assumed to be a composite system of $N-\bar{N}$, the backward peak in $\pi^{\pm}-p$ scattering at about 4 GeV/c is treated by rearrangement scattering formalism. The shape and the height of the backward peak depends on the constructive force binding $N-\bar{N}$, which in turn works as an interactive force in the rearrangement scattering. From the experimental data, the result is obtained that this force has a range of about the nucleon Compton wave length and a stretch of about 10 GeV. The energy dependence of the angular distribution, the possibility of attributing the second peak of the angular distribution to the rearrangement mechanism, the small backward peak in $\pi^{-}-p$ scattering as a result of the rearrangement scattering, etc. are discussed. (auth)

13711 ON THE BARYON MASS LEVELS. II. Yamazaki, Masatoshi; Hori, Shoichi (Kanazawa Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 1035-43(Nov. 1966).

In a previous note the baryons were assumed to be nonrelativistically and strongly bound three-body systems of fundamental triplets, and their mass differences were attributed mainly to rotational kinetic energy differences and partly to spin–orbit coupling perturbations. A refinement of this idea is considered in the following two points. Firstly the number of low lying mass levels obtained in the previous note is diminished by taking explicit account of the internal (vibrational) degree of freedom of the three-body bound state. Secondly, spin-orbit coupling perturbation calculations are carried out after Derrick's triton recipe; this results in no major change of the conclusions previously given. Through the comparison of calculated mass levels with the experimental data, the magnitude of the ratio of the hard core radius to the range of the potential between two constituents is discussed. (auth)

13712 STATIC PION THEORY AND SUM RULES. Miyazawa, Hironari (Tokyo Univ. Argonne National Lab., Ill.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 315-21(1966).

Sum rule for the renormalization of the axial-vector current is investigated in the static pion theory. Effect of nucleon pair creation is included, although the nucleon recoil effects are neglected. Result is consistent with the observed value, and it is concluded that the static pion theory can give reasonable results for the renormalization of axial-vector current. (auth)

Strong (Baryon No. ≥ 2)

13713 (SLAC-PUB-256) INFORMATION ABOUT THE TWO AND THREE NUCLEON SYSTEMS OBTAINED AND OBTAINABLE FROM THE USE OF POLARIZED TARGETS AND BEAMS. Noyes, H. Pierre (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Jan. 1967. Contract AT(04-3)-515. 51p. (CONF-661205-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Polarized Targets and Sources, Saclay, France.

Review of recent experiments and theory makes it clear that the spin structure of the three-nucleon system is too complicated to allow a direct determination of the scattering matrix in the near future. In order to provide more readily applicable tools for experimental analysis, the rigorous three-body theory provided by the Faddeev equations should be articulated to provide a low energy n-d theory comparable to effective range theory, a unitary parameterization for the coupled elastic scattering and breakup problems comparable to phase shift analysis, and a theory of high angular momentum states based on the deuteron wave function analogous to one-pion-exchange for the N-N system. As physical input both better nucleon-nucleon scattering measurements, particularly in the n-p system, and a method for extending these results to the energy-momentum regions allowed by the uncertainty principle in the three-nucleon system are also required. Whether it is attempted to derive this extension from electromagnetic measurements of the two-nucleon wave functions, or directly from two-nucleon scattering, it is found that this extension requires understanding of the coupling of the nucleon-nucleon system to other elementary particles. Thanks to the high precision of recent nucleon-nucleon scattering measurements provided by polarization techniques, it is found that all the characteristic features of the two-nucleon interaction can in fact be interpreted as arising from the exchange of known bosons and boson resonances, and hence that this extension can possibly be made in a physically reasonable way. It is concluded that the three-nucleon problem should be approached both phenomenologically and from the point of view of elementary particle physics, and that the coupling of these two approaches offers great promise, if kept in close contact with experiment, and if full use is made of the new polarized target and polarized beam techniques. (auth)

13714 ANALYTICITY PROPERTIES OF THE MESON–DEUTERON ELASTIC-SCATTERING AMPLITUDES AT LOW ENERGY. Ando, Fujio; Feldman, David (Brown Univ., Providence). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 524-72(1966). (NYO-2262-121).

A dispersion-theoretic treatment of the elastic scattering at low energy of mesons by deuterons is presented. The loosely bound nature of the deuteron results in small anomalous thresholds of the scattering amplitudes in the t channel and justifies the use of selected Feynman diagrams in the determination of the general analyticity properties of the amplitudes. The impulse approximation, binding corrections, and multiple-scattering terms are defined in terms of both triangle and box diagrams, and the dispersion relations with fixed s for these terms are derived by the method of analytic continuation with respect to the deuteron mass and with respect to s. It is found that the anomalous parts of the deuteron-baryon vertices play important roles in the derivation of the dispersion relations, and that the double-scattering amplitudes have no complex singularities. The general method is applied to a determination of the angular distributions for π^{+}d and K^{-}d elastic scattering. In the former case, the binding correction due to $N_{\frac{1}{2}}^{*}$ is the main correction to the impulse approximation. In the latter case, the impulse approximation is determined in terms of the $\bar{K}N$ scattering amplitudes, which are approximated by two complex poles. (auth)

Particle Invariance Principles and Symmetries

General

13715 (IFA-FT-62) NON COMPACT SYMMETRY GROUPS, UNITARY S-MATRIX AND QUANTUM FIELD THEORY. Nguyen Van Hieu (Academia R. P. R., Bucharest, Institutul de Fizica Atomica). 1966. 25p. Dep. mn.

The noncompact symmetry groups and their connections with field theory are studied. It is proven explicitly that in the noncompact group symmetries there exists no contradiction with the unitary condition of the S-matrix. It is shown that the relations between scattering amplitudes obtained by considering the collinear subgroup of the noncompact symmetry group, are not identical with the $SU(6)_W$ predictions. A method to describe the symmetry with a noncompact group by means of the methods of local quantum field theory is suggested. Within the method, the field operators satisfy the normal commutation relations, and the S-matrix is crossing-symmetrical. (auth)

13716 BEHIND THE CPT MIRROR. Rashid, M. A.; Ahmad, K.; Kazi, R. A. Nucleus (Lahore), 3: No. 1-2, 12-14(Jan.-June 1966).

CPT invariance is reviewed. Symmetries and decays of the meson (η) are considered. The implications of the experimental results for asymmetry in the meson (η) decay are discussed. (J.F.P.)

13717 MUTUALLY RECIPROCAL "CONTRACTION" AND "EXPANSION" OF CERTAIN LIE ALGEBRAS. Rosen, J. (Boston Univ.). Nuovo Cimento (10), 46B: 1-6(Nov. 11, 1966).

A unified demonstration of expanding the Lie algebra of IO(p,q) to that of O(p + 1,q) or O(p,q + 1) and contracting the latter to the former is presented. It is shown that a corresponding scheme can be developed for IU(p,q) and U(p + 1,q) or U(p,q + 1). (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 13694.

13718 (DESY-66/30) ON THE TEST OF T-INVARIANCE IN ELASTIC SCATTERING OF ELECTRONS FROM POLARIZED DEUTERONS. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 11p. Dep. mn.

An additional (magnetic) form factor G_2 which violates T-invariance is introduced in the electromagnetic vertex of the deuteron. This additional interaction yields a right-left asymmetry in the scattering of electrons from polarized deuterons. For our numerical evaluations values of G_2 were used which are consistent with the deviations from the impulse approximation found in measurements of the unpolarized cross section. A maximum asymmetry of approximately 40 percent was obtained at $q = 3.5$ f^{-1}. However, care must be taken in the preparation of the polar-

ized target, as a suitable tensor polarization may also produce asymmetry. (auth)

13719 (JINR-E2-3102) ^{189}W AND MESON DECAYS. Robashik, D.; Ulmann, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 20p. (In Russian). Dep. mn.

In the $SU(6)_w$ frame the decay probabilities of the 189-plet into two negative parity mesons were calculated. Relations were obtained between collinear reduced matrix elements (only invariant by Lorentz transformations in z-direction). After developing the usual Lorentz invariant matrix elements in helicity state amplitudes, they are connected with the reduced matrix elements. The results obtained are compared with the experimental data. (auth)

Applications (Strong)

13720 LORENTZ COVARIANT CHIRAL U(6) X U(6) SCHEME OF BARYON–MESON INTERACTIONS. Itabashi, Kiyomi (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 94-113(1966).

It is attempted to extend the concept of current algebra to the domain of strong interactions. The idea is as follows: In the weak leptonic processes, the hadrons are subjected to transformations induced by certain generators of chiral U(6) × U(6) algebra, whereas the strong baryon-meson interactions are invariant under the chiral U(6) × U(6) transformations as well as space reflection and charge conjugation. Conventional way of particle assignment in current algebra is essentially of static nature, and inadequate for the treatment of strong interactions in which the baryon momentum transfers are not negligible. Therefore all the particle assignments are made in a manifestly Lorentz-covariant way. Representations considered are (21,6) ⊕ (6,21) and (36,1) ⊕ (1,36). The former consists of the baryons whose spin-parity and SU(3) properties are ($\frac{1}{2}^+$; 8), ($\frac{3}{2}^+$; 10), ($\frac{1}{2}^-$; 1), ($\frac{1}{2}^-$; 8), ($\frac{1}{2}^-$; 10), and ($\frac{3}{2}^-$; 8), whereas the latter consists of the mesons (0^-; 8 and 1), (1^-; 8 and 1), (0^+; 8 and 1), and (1^+; 8 and 1). The resultant pseudoscalar meson coupling is of the PCAC type, i.e., the coupling through the four-dimensional divergence $\partial_\mu J_\mu^A$ of the axial-vector baryon currents. The proposed interaction scheme contains only one free parameter, which is normalized so as to give $G^2_{NN\pi}/4\pi = 14$. With this normalization, very good values are predicted for the NΣK and NΛK coupling constants and also for the decay widths and branching ratios of ($\frac{3}{2}^+$; 10) baryon resonances and $Y_1^*(1405)$ [assigned to ($\frac{1}{2}^-$; 1)]. However, the predicted width of $N_N^*(1518)$ [assigned to ($\frac{3}{2}^-$; 8)] is too large compared to experiment. (auth)

Quantum Field Theories

Refer also to abstract 13702.

13721 (AD-640153) CONSISTENCY OF CURRENT COMMUTATORS. Revised Edition. Goldberg, Irwin; Marx, Egon (Aerospace Research Labs., Wright-Patterson AFB, Ohio). 1965. 15p. CFSTI $3.00 cy, $0.65 mn.

An apparent paradox is presented that originates from current commutators in quantum electrodynamics, followed by its solution. The presentation made of the same (or a closely related) paradox by Schwinger in 1959 and Johnson in 1961 is discussed. The conclusion is that there is no need to modify the current commutators. (auth)

13722 (DESY-66/31) ON LOCAL ONE-PARTICLE APPROXIMATIONS AND LOCALLY CONSERVED CURRENTS. Voelkel, A. H. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II). Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 25p. Dep. mn.

Local one-particle approximations are constructed for matrix elements of two local field operators. If one of the fields is a locally conserved current the approximation is extended in such a way that both locality and current conservation are valid in the approximation. (auth)

13723 (DESY-66/36) EIGENSCHAFTEN DER KOEFFIZIENTEN DER ZERLEGUNG DES FELDOPERATORS NACH ASYMPTOTISCHEN FELDERN. (Characteristics of the Coefficients of the Analysis of Field Operators According to Asymptotic Fields). Pohlmeyer, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 79p. (In German). Dep. mn.

In the Wightman framework of axiomatic quantum field theory it is proved that the interpolating field can be expanded in terms of the asymptotic fields on a dense set. The distribution character of the expansion coefficients is established, and their asymptotic behavior, their smoothness properties and their one-particle structure are investigated. The interrelation among these expansion coefficients and their connection with the amputated retarded functions is studied. (auth)

13724 (DESY-66/38) SPONTANEOUS BREAKDOWN OF SYMMETRIES AND ZERO-MASS STATES. Ezawa, H.; Swieca, J. A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec. 1966. 13p. Dep. mn.

In a relativistic field theory Goldstone's theorem is proved without any assumption about the existence of covariant fields and for arbitrary expectation values. (auth)

13725 (SLAC-PUB-250) HIGH ENERGY BEHAVIOR OF LOCAL QUANTUM FIELDS. Jaffe, Arthur M. (Stanford Linear Accelerator Center, Stanford Univ., Calif. Stanford Univ., Calif. Dept. of Mathematics). Dec. 1966. Contract AT(04-3)-515. 24p. (CONF-661210-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Stanford, Calif.

Quantum field theories having singular high-energy behavior are considered. The idea of a strictly localizable field is defined, and it is shown that it is possible to work out the general principles of field theory for any field which is localizable in that sense. These fields are considered on an equal basis with those usually studied. Also a useful high-energy bound is derived from strict localizability. (J.F.P.)

13726 ON THE DOMAIN OF THE TOTAL HAMILTONIAN IN QUANTUM FIELD THEORY. Miyatake, Osamu (Univ. of Osaka Prefecture); Kato, Yusuke. Progr. Theoret. Phys. (Kyoto), 36: 1054-67(Nov. 1966).

The following question is considered: Has the total Hamiltonian any domain in the Hilbert space spanned by the eigenstates of the free Hamiltonian? Two simple cases are considered as examples. One is a system consisting of charged and neutral boson fields and a point surface fixed in space, where the source has two states in charge–space, positive and neutral. The other is a system consisting of a neutral pseudoscalar boson field and a fermion–antifermion field. In the former case, it is proved that the total Hamiltonian has no domain. In the latter, the same conclusion is partially obtained. (auth)

13727 VIEW OF ELEMENTARY PARTICLE PHYSICS BASED ON THE RENORMALIZATION THEORY. Okabayashi, Takao (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 46-55(1966).

Various aspects of renormalization theory are discussed from a new standpoint. Especially, the possibility is explained of using the image inherent in the renormalization philosophy in order to get a deeper understanding of the pseudo-quantum numbers such as parity, hypercharge and isotopic spin which are not always conserved. (auth)

13728 QUANTUM THEORY OF GENERALIZED GAUGE FIELD. Goto, Tetsuo (Nihon Univ., Tokyo); Utiyama, Ryoyu. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 322-37(1966).

A canonical quantum theory of a system which is invariant under the generalized gauge group is investigated by following the approach of Rosenfeld. The Lorentz condition is introduced in order to make the whole set of equations invariant under Lorentz transformations. The requirement of the gauge invariant of the Lorentz condition itself leads to the necessity of q-number gauge. A brief discussion is made about the interaction representation of this system. (auth)

13729 POSSIBILITY OF A FURTHER GENERALIZATION OF FIELD QUANTIZATION. Kamefuchi, Susumu (Tokyo Univ. of Education); Takahashi, Yasushi. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 244-54(1966).

A possibility is suggested of a further generalization of the method of field quantization which was previously developed. Only the R-method is considered. The generalization consists in modifying the expression for the number operators in terms of creation and annihilation operators, which is analogous to the expression for the spin operator in the general theory of relativistic wave equations of Dirac–Pauli–Fierz and Harish–Chandra. Such a generalization leads to new results only in the cases of order $(s-1) \geq 3$. Quantum mechanics of a simple harmonic oscillator is discussed in detail, and generalized commutation relations are given. Field theory quantized by this method is studied and some general features are discussed. It is shown that in the cases of $(s-1) \geq 3$ the field theory thus obtained is in general not equivalent to ordinary para-field theory. (auth)

13730 BOUND STATES AND THEIR STATISTICS IN PARA-FIELD THEORY. Ohnuki, Yoshio (Univ. of Nagoya, Japan). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 285-96(1966).

Bound states, constituents of which satisfy a para-statistics, are examined. It is shown that in some cases the statistics of bound states becomes of a new type not described in terms of the

usual para-field theory. Properties of the new statistics are discussed. (auth)

13731 ON THE FUNDAMENTAL CONCEPTS IN THE THEORY OF ELEMENTARY PARTICLES. I. HISTORY OF THE TOMONAGA THEORY OF FIELDS. Taketani, Mituo (Rikkyo Univ., Tokyo); Nakamura, Seitaro; Fujimoto, Yoichi. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 433-9(1966).

The history of the formation of Tomonaga's super-many-time theory of fields and renormalization theory and the contributions resulting from collaboration of Japanese physicists to its development are discussed. (L.B.S.)

13732 TRANSFORMATION PROPERTIES OF THE RIGID SPHERE WAVE FUNCTIONS AND THEIR RELATION TO THE DIRAC SPINOR. Hara, Osamu; Tsai, S. Y.; Yabuki, Haruichi (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 495-506(1966).

It is shown that the wave functions of a rigid sphere belonging to the eigenvalue $J = \frac{1}{2}$, where J denotes the magnitude of the angular momentum due to the rotation of the sphere around its center of mass, transform in exactly the same way as the Dirac spinor under the spatial rotation, space inversion and the Lorentz transformation, and that the Dirac equation is derived automatically from the properties of these wave functions. (auth)

13733 TREATMENT OF OVERLAPPING DIVERGENCES IN THE PHOTON SELF-ENERGY FUNCTION. Mills, R. L.; Yang, C. N. (State Univ. of New York, Stony Brook). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 507-11(1966).

An analysis is made of the generalization of Ward's identity to the problem of renormalizing the photon self-energy function in quantum electrodynamics. It is shown that it is nontrivial to select a path of differentiation in a consistent way through the different self-energy graphs, but that a suitable set of simple rules can be given which completely resolves the overlapping divergence difficulty in the photon self-energy function. (auth)

13734 ATOMISTICS AND THE DIVISIBILITY OF SPACE AND TIME. Yukawa, Hideki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 512-23(1966).

A model is constructed to show how the atomistic structure of matter and energy can be reconciled with the assumption of unlimited divisibility of space and time on the subnuclear level. The concept of an elementary particle as an object which occupies an elementary domain is considered, and further generalizations and abstractions of the model are made in order to approach a realistic theory of extended particles. (L.B.S.)

13735 COMMENTS ON DIRAC'S THEORY OF MAGNETIC MONOPOLES. Wentzel, Gregor (Univ. of Chicago). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 163-74(1966).

Dirac's modified field-vector potential relation is discussed and elaborated in various directions, e.g., to include the case of a monopole wave-packet. A way to incorporate monopoles into Tomonaga's quantum-electrodynamics is pointed out. Contributions from virtual pole-antipole pairs are discussed with the use of duality aspects. (auth)

13736 RENORMALIZATION THEORY. Caianiello, E. R. (Univ., Paris); Guerra, F.; Marinaro, M. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 183-91(1966).

A formalism of renormalization theory is presented in which meaningful equations and quantities are obtained by performing all operations directly on the propagators. The discussion is confined to a neutral scalar field φ with self-coupling $g\varphi^4$ for simplicity; the extension to all other instances of interest would be immediate. (L.B.S.)

13737 CURRENT ALGEBRAS IN A SIMPLE MODEL. Johnson, K.; Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 74-93(1966). (MIT-2098-239).

Third and fourth order perturbation theory is used in a renormalizable interacting quark model to compare operator parts of equal time commutators with their conventionally expected values. In the case of matrix elements between spin-less states, all commutators have extra terms except the V_0, A_0 algebra, $[V_j,A_k]$, [S,S], [S,P], and [P,P]. If a neutral vector field coupled to quark number is also considered, then $[V_0,A_0]$ and $[V_j, A_k]$ acquire extra terms. If, in addition, V currents which are even and A currents which are odd under charge conjugation are present, it is conjectured that only the doubly integrated V_0, A_0 algebra remains intact. The same comment applies to S and P currents with negative C parity. The Jacobi identify in general fails for successive equal time commutators (this is because an interchange of limits is involved, although it holds (in our model) for the V_0, A_0 algebra). (auth)

13738 VACUUM REFRACTION INDEX IN THE PRESENCE OF EXTERNAL FIELDS. Baier, R.; Breitenlohner, P. (Univ. of Graz). Nuovo Cimento (10), 47B: 117-20(Jan. 11, 1967).

In order to derive the index of refraction for a photon propagating in external fields, the Maxwell equations for a plane-wave radiation field are solved. Results are given for the case when either E or B vanishes and for the case when both fields are present. Polar birefringence, which occurs when an electric and magnetic field are mutually perpendicular and satisfy $|E| = |B|$ and a photon moves perpendicular to E and B, is also discussed. If this system is right-handed there is no refraction, but if it is left-handed, birefringence occurs. (J.F.P.)

Scattering Theory

13739 UNITARITY RELATION IN AN IMPACT PARAMETER REPRESENTATION. Adachi, Toshimi (Tokyo Metropolitan Technical Coll.); Kotani, Tsuneyuki. Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 297-305(1966).

The unitarity relation for impact parameter amplitudes can be expressed in a transparent form by using phase functions. There is no essential difference for the theoretical treatment of both partial-wave and impact-parameter amplitudes, whenever the reaction (or inelastic) channels have to be taken into account. The threshold behavior of the impact-parameter amplitude is shown by using the effective range theory. The imaginary part of the impact-parameter phase function is not equal to zero even below the lowest threshold of the reaction channels, while the non-zero value of the imaginary part of the partial-wave phase shift corresponds to the existence of the reaction channels. At the higher energies or the large values of the impact parameter, the impact-parameter amplitude becomes equal to the partial-wave amplitude of the corresponding orbital angular-momentum state. (auth)

13740 FORWARD SCATTERING AMPLITUDE AT HIGH ENERGY. Kinoshita, Toichiro (Cornell Univ., Ithaca, N. Y.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 67-73(1966).

Recently Martin has enlarged the domain of analyticity of the scattering amplitudes substantially within the framework of axiomatic field theory. Although it is still much smaller than that assumed in the Mandelstam representation, it already imposes rather strong restrictions on the properties of the scattering amplitude. A review is presented of some recent results concerning the high-energy behavior of forward scattering amplitudes which are derived from unitarity and rigorously proved analyticity. (auth)

13741 INFINITELY STRONG POTENTIAL OF FINITE RANK. Tani, Smio (Marquette Univ., Milwaukee). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 473-94(1966).

The scattering off a potential of finite rank (a sum of a finite number of separable potentials) is studied thoroughly in the neighborhood of infinity of potential strength; for this purpose the "strong coupling representation" is introduced by means of a canonical transformation. The same K matrix as for the infinitely strong repulsion is derived for the infinitely strong attraction. The difference between attraction and repulsion for a large but finite magnitude of strength can be understood in terms of the effects from bound states and excited states which exist for attraction and repulsion, respectively. It is shown that this difference disappears from the K matrix at low energies as the potential strength tends to infinity. The high-energy behavior of the phase shift shows a characteristic difference between the two cases for a large but finite magnitude of strength. Levinson's theorem is discussed lucidly, and it is discussed how to interpret the identical result in the K matrix at infinity for both attraction and repulsion. (auth)

13742 NONDYNAMICAL STRUCTURE OF INELASTIC SCATTERING OR REACTIONS OF SPIN TYPE $1 + 0 \rightarrow 1 + 0$. Duenn, K.; Fick, D. (Univ., Erlangen-Nuremberg). Z. Phys., 199: 309-24(1967).

The nondynamical M-matrix formalism is applied to the inelastic scattering or to reactions of spin type $1 + 0 \rightarrow 1 + 0$. It is shown how the parameters of the M-matrix, which contain all dynamical information, can be determined by experiments. There are two M-matrices M_+ and M_-, one (M_+) for the case in which the product of the intrinsic parities of all interacting particles is +1 and one (M_-) where this product is −1. In the case of M_- one can avoid triple scattering parameters to determine fully the M_--matrix. (auth)

13743 REAL ANALYTIC COVARIANT FUNCTIONS AND THEIR ANALYTIC CONTINUATION IN COMPLEXES. Seiler, Rudolf (Eidgenoessiche Technische Hochschule, Zurich). Helv. Phys. Acta, 39: 641-64(Dec. 30, 1966). (In German).

In trying to develop an S-matrix theory based only on physical

assumptions two theorems were formulated by H. Stapp about the analytic continuation of real analytic Lorentz-covariant functions. A generalization of these theorems with regard to orthogonal and symplectic groups is presented. (auth)

Particle Accelerators

Refer also to abstracts 12733 and 13471.

13744 (AD-639919) COMPUTATION OF NUCLIDE YIELD IN A 60-INCH CYCLOTRON. Liben, W. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). July 1966. Contract NOw-62-0604. 73p. (TG-837). CFSTI $3.00 cy, $0.65 mn.

Two procedures are described for computing the yield of isotopes in a 60 in. cyclotron. Both are based on the basic yield equation sigma (E)N_p (N_T), where sigma is the excitation function, N_p the number of bombarding particles, and N_T the number of target atoms. The excitation function is only available from laboratory measurements. N_p is proportional to the cyclotron beam current and is constant with time and position in the target, but the particle energy decreases as it penetrates into the target. The yield depends upon N_p (N) (sigma)dx where N is the number of target atoms per cubic centimeter and dx is a thin slice of the target. A rough approximation to the yield is possible if sigma is taken to be constant; the yield is then given by N_p (N) (sigma) (Range). The stopping power dE/dx is discussed in detail, including methods for computing the function. Detailed computations are given for the B10 (dn) C11 reaction using rough and more exact procedures. In the Appendix are collected the yield curves for a few short-lived isotopes useful in making radiopharmaceuticals. (auth)

13745 (CEAL-1033) SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY 1 THROUGH JUNE 30, 1966. Livingston, M. Stanley (Massachusetts Inst. of Tech., Cambridge. Cambridge Electron Accelerator, Mass.). Dec. 6, 1966. Contract AT(30-1)-2076. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The purpose of the contract, which is concerned with the operation of the 6-GeV Cambridge Electron Accelerator is indicated. The general nature of each of the 36 experiments that were in progress or in preparation during the six-month period in question are stated. The principal improvements made in the accelerator and the associated facilities are listed. The routine operation of the accelerator is discussed and the half-year in question was the most productive such period to date is indicated. The safety organization, which has been greatly improved is described. Plans and preliminary tests made in preparation for the colliding beam facility BYPASS are summarized; crucial tests made to date, including storage of multi-GeV electrons for periods of the order of 10 minutes (limited only by scattering from residual gas) have been successful. (auth)

13746 (CEAL-1034) NEW RADIAL SURVEY OF THE RING OF 48 MAGNETS AND CONSEQUENT RADIAL DISTORTIONS OF THE EQUILIBRIUM ORBIT. Shurcliff, W. A.; Robinson, K. W.; Collins, T. L.; Boyd, M. (Massachusetts Inst. of Tech., Cambridge. Cambridge Electron Accelerator, Mass.). Jan. 9, 1967. Contract AT(30-1)-2076. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

After a five-year interval, the radial positions of the 48 magnets of the Cambridge Electron Accelerator were resurveyed. The rms error in radial position was found to be about 0.025 inch. Calculations show that the magnitudes and phases (locations) of the errors were such as to produce distortions of 0.2 to 0.4 inches in the equilibrium orbit. The magnet positions were then readjusted. Spot checks suggest that, as far as the important harmonics are concerned, the magnets now lie within perhaps 0.005 inch of a true circle. The computer program required was rewritten for the IBM 7094 computer, and is being extended to show not only the errors in magnet position but also the consequent distortions of the equilibrium orbit. It is expected that it will suffice to make radial surveys only every five years. (auth)

13747 (CERN-66-35) DESIGN AND TUNING PROCEDURES OF GROUNDED-GRID POWER AMPLIFIER. Susini, A. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 24, 1966. 29p. Dep. mn.

The analysis of wide-band networks, suitable for multistage synchrocyclotron machines is presented. A graphic-analytical method is shown, to examine the functioning of the cathode network of a wide-band grounded-grid amplifier when the anode load is a double-peaked one. More complicated anode loads can also be treated in the same way. A guide to tuning operations is also presented since these are not too evident due to the strong coupling existing between anode and cathode circuits, and due to the tube secondary effects which, at 30 Mc frequency, just begin to become appreciable. The analysis is divided into two parts: an introduction, where the preliminary operations to be performed at reduced load are indicated; and the subject proper, where the various current and voltage wave forms, which appear at the various points of the cathode network when a well-tuned system is being wobbulated, are shown. (auth)

13748 (CONF-650923-32) COHERENT ACCELERATION OF PROTONS. Mills, F. E. (Midwestern Universities Research Association, Stoughton, Wis.). Sept. 1965. Contract W-31-109-eng-32. 8p. DTIE.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

A method is described by which electric fields associated with an unstable electron beam might be made to interact with a group of protons for a long time thereby producing very high velocity protons. The method entails imbedding an electron beam in a plasma. The function of the plasma is to modify the velocity of propagation of the electromagnetic waves in the beam to match that of the injected protons. Spatial variation of the velocity of this wave causes the electric field to keep step with the protons as they are accelerated. (B.G.D.)

13749 (CONF-650923-33) DESIGN OF A 200 MeV ELECTRON–POSITRON STORAGE RING. Rowe, E. M.; Meier, H. K.; O'Meara, J. E. (Midwestern Universities Research Association, Stoughton, Wis.). Sept. 1965. Contract W-31-109-eng-38. 18p. DTIE.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

A 200 MeV electron-positron storage ring, which was designed for studying colliding beam and high intensity beam phenomena, is discussed. Topics included are magnet and magnet power supplies; injection system; beam lifetime; rf system; beam observation, beam clearing, and beam instability damping systems; and vacuum system. The parameters for the storage ring are also presented. (B.G.D.)

13750 (CONF-650923-34) DESIGN STUDY OF A 500 MeV FFAG INJECTOR. Snowdon, S. C.; Christian, R. S.; Rowe, E. M.; Curtis, C. D.; Meier, H. K. (Midwestern Universities Research Association, Stoughton, Wis.). Sept. 1965. Contract W-31-109-eng-38. 24p. DTIE.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

A design study is presented for a 500 MeV FFAG accelerator capable of delivering 1.6×10^{14} protons per second. The output beam has an energy spread of ±0.68 MeV with transverse emittances of 6.74 millirad-cm (horizontal) and 1.61 π millirad-cm (vertical). The output beam contains 8.4×10^{12} protons in 71 nanosecond long pulses repeated 30 times per second. (auth)

13751 (CONF-650923-35) RESONANT STABILITY LIMITS FOR SYNCHROTRON OSCILLATIONS. Symon, K. R.; Steben, J. D. (Midwestern Universities Research Association, Stoughton, Wis.); Laslett, L. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1965. Contract W-31-109-eng-38. 30p. DTIE.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

In high energy proton synchrotrons now under investigation, the rapid acceleration rates and the high harmonic numbers contemplated lead to a number ν of synchrotron oscillations per revolution near to unity. In this case phase oscillations are susceptible to both inherent and imperfection resonances analogous to those observed in betatron oscillations. The analytical theory of synchrotron oscillations is extended to treat this case and digital computation of orbits is employed to supplement and verify the theory. The case of a single accelerating gap is considered as an example. Expressions for the synchrotron oscillation frequency in this regime are presented. Effects of errors in voltage and phase are computed and the existence of stop-bands demonstrated. (auth)

13752 (CONF-650923-36) DIAGNOSTICS AND CONTROL OF A COHERENT INSTABILITY IN THE MURA 50 MeV ELECTRON ACCELERATOR. Pruett, C. H.; Otte, R. A.; Mills, F. E. (Midwestern Universities Research Association, Stoughton, Wis.). Sept. 1965. Contract W-31-109-eng-38. 16p. DTIE.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

The first five unstable modes of a coherent vertical instability existing in the MURA 50-MeV electron accelerator have been successfully suppressed by a wide band electronic system. These are the only modes that it has been possible to make unstable in the accelerator. They are characterized by frequencies (observed at a fixed accelerator azimuth) given by $\Omega = f_0 (n - \nu_z)$ where f_0 is the revolution frequency (≈24.2 Mc) and ν_z is the vertical betatron

oscillation frequency (≈2.7). The system has a bandwidth extending from 4 to 150 MHz which is sufficient to suppress the first seven unstable modes (n = 3, 4, 5, 6, 7, 8, 9). Parameters of the system and its method of operation are discussed. Measurements of growth and damping rates for the instability with and without the system in operation are described. (auth)

13753 (LA–3567) OPTIMUM GEOMETRIES AND FIELD STRENGTHS FOR ALVAREZ LINACS. Swenson, Donald A. (Los Alamos Scientific Lab., N. Mex.). June 18, 1966. Contract W-7405-eng-36. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A procedure is described for selecting the geometries and field strengths for an Alvarez linac which will produce a linac of a given performance for the least cost. The geometries considered in this study are restricted to cylindrical cavities, loaded with cylindrical drift tubes having a cylindrical hole for passage of beam, and rounded corners (outer corner and hole corner) to reduce the high electric fields that would otherwise appear on the sharp corner. Several thousand cavities of this type have been evaluated by the MURA group with their linac field computational program, MESSYMESH. The analysis described here is based on these computations. It is possible to display data from hundreds of MESSYMESH computations on a pair of graphs in such a way as to facilitate the evaluation of the economics. The data on these graphs are independent of the various cost coefficients which enter into the cost formula and are subject to change. Given these cost coefficients, it is a simple matter to select the optimum field strength and the optimum geometry with the aid of the graphs. (auth)

13754 (LA-DC-8243) TUNING AND FIELD MEASUREMENT TECHNIQUES IN A RESONANTLY COUPLED ACCELERATOR TANK. Engel, Lars N.; Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). Sept. 13, 1966. Contract W-7405-eng-36. 19p. (CONF-661021-30). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

The tuning and measurements made on a long cavity chain designed to check the predictions of the theory and develop fabricational and tuning techniques useful for mass production of cavity chains of this type. An 805 MHz, side-coupled, 39 accelerating cell, experimental model was fabricated and tuned. (B.G.D.)

13755 (LA-DC-8244) ACCELERATING STRUCTURE RESEARCH AT LOS ALAMOS. Knapp, E. A.; Allison, P. W.; Emigh, C. R.; Engel, L. N.; Potter, J. M.; Shlaer, W. J. (Los Alamos Scientific Lab., N. Mex.). Sept. 26, 1966. Contract W-7405-eng-36. 17p. (CONF-661021-32). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

The use of a side coupled accelerator tank for the proposed LAMPF linear accelerator is discussed. Several refinements in design which raise the shunt impedance of this type system are outlined. High power tests were run which show that the design will withstand high gradient operation with no adverse characteristics. (B.G.D.)

13756 (LA-DC-8245) TRANSVERSE MODES IN A RESONANTLY COUPLED ACCELERATOR. Potter, J. M. (Los Alamos Scientific Lab., N. Mex.). Sept. 29, 1966. Contract W-7405-eng-36. 20p. (CONF-661021-33). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

In predicting the possibility of transverse mode beam blow-up in a linear accelerator it is useful to have some idea of the transverse mode shunt impedance of a typical accelerating cell. The techniques for identifying the modes associated with beam blow-up and for measuring their shunt impedance are discussed. A family of six $\beta = 0.65$ cavities of a similar geometry and varying diameters, typical of the accelerating cells in the LASL $\pi/2$ mode structures, and with the TM_{010} mode near 805 MHz were studied. The results of these measurements are presented. (auth)

13757 (LA-DC-8246) MECHANICAL DESIGN OF DRIFT TUBES AND QUADRUPOLE MAGNETS FOR THE ALVAREZ LINAC. Bush, E. D. Jr. (Los Alamos Scientific Lab., N. Mex.). Sept. 21, 1966. Contract W-7405-eng-36. 19p. (CONF-661021-29). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

The efforts at Los Alamos directed toward the mechanical design of drift tubes, drift tube stems, and quadrupole magnets for the 201.25 MHz Alvarez linac are described. The linac features necessitating this design effort are the high rf duty factor which may go as high as 12%, and the large time average current of one mA. Topics covered are limited to preliminary drift tube design with emphasis placed on the quadrupole magnets and their associated coils. In the following sections current drift tube designs, cooling schemes, and fabrication techniques are discussed. The approach to the quadrupole magnet design, fabrication and analysis is outlined along with a description of the coated coil development program. (auth)

13758 (LNF–66/55) PAPERS PRESENTED AT INTERNATIONAL SYMPOSIUM ON ELECTRON AND POSITRON STORAGE RINGS, SACLAY, SEPTEMBER 1966. PART I. Note No. 336. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali de Frascati). Nov. 15, 1966. 22p. Dep. mn.

Separate abstracts were prepared for the 4 papers presented. (B.G.D.)

For abstracts of individual papers see: 13759–13762.

13759 (LNF–66/55, pp 3-9) ADONE STATUS REPORT. Amman, F.; Andreani, R.; Bassetti, M.; (and others). (CONF-660939–3).

The Adone storage ring is described and many of its parameters are reported. Also discussed are the injector, injection optics and pulsed inflector, magnet and magnet power supply, vacuum system, rf system, buildings, and time schedule. (B.G.D.)

13760 (LNF–66/55, pp 11-14) INSTABILITY OF INTENSE ELECTRON BEAM AND RADIOFREQUENCY SYSTEM IN A STORAGE RING. Bassetti, M. (CONF-660939–4).

The instability of intense electron beams and rf systems in a storage ring are studied by the method of finite differences. (B.G.D.)

13761 (LNF–66/55, pp 15-18) INCREASE OF THE LONGITUDINAL DIMENSION OF A RELATIVISTIC BUNCH DUE TO THE COHERENT-RADIATION FORCE. Ferlenghi, E. (CONF-660939–5).

A derivation is presented which shows the relation between the coherent-radiation force and the increase of the longitudinal dimension of a relativistic bunch. This condition is related to the Adone storage ring. (B.G.D.)

13762 (LNF–66/55, pp 19-22) REMARKS ON MULTIPLE COULOMB SCATTERING IN A RELATIVISTIC ELECTRON BEAM, BEAM SIZE AND LIFETIME. Pellegrini, C. (CONF-660939–6).

In the Coulomb scattering of two electrons belonging to the same bunch of a relativistic beam moving inside a circular accelerator, the particle energy changes and hence influences both the lifetime and the beam size. Up to now this effect has been evaluated in the case of a flat beam, i.e., a beam whose dimension in the direction orthogonal to the medium plane of the machine is zero, and when the scattering is non-relativistic in the center of mass system of two electrons. It is shown how valid these approximations are. (B.G.D.)

13763 (NP–16501) ETUDE PRELIMINAIRE DU DOSAGE PAR FLUORESCENCE X DE COUCHES MINCES D'ERBIUM ET DE TITANE. (Preliminary Study of X Fluorescence of Thin Layers of Erbium and Titanium). Pluchery, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1965. 15p. (In French). Dep. mn.

The precision with which the thickness of very thin layers of Ti and Er can be deposited on supports of Cu or Ag to be used as accelerator targets was evaluated. The selection of the optimum measurement conditions was studied and the limit of detection and of the precision was evaluated. The preliminary results show that the detection limit for the thickness of the Ti layers would be 2 and 1.3 Å for Cu and Ag respectively with a precision of 1.7 and 1.2 Å respectively. For Er a detection limit of 1.7 and 1.3 Å was found respectively for Cu and Ag and a precision of 1.3 and 1 Å respectively. These results can be considered only as an order of magnitude valid by a factor of two. (J.S.R.)

13764 (PPAD–609D) ACCELERATOR BEAM DEGENERATION FROM AMPLIFIED SHOT NOISE. Isaila, M. V.; Passner, A.; Pease, R. L. (Princeton–Pennsylvania Accelerator, Princeton, N. J.). Dec. 20, 1966. Contract AT(30-1)-2137. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From observations of, and calculations on, beam degeneration observed under artificial conditions at the Princeton-Pennsylvania Accelerator, it was possible to attribute the degeneration primarily to high-frequency components of ordinary shot noise, amplified in a state of longitudinal instability. (auth)

13765 (RHEL/R–103) IPSO FACTO: A PROGRAM FOR CALCULATING BEAM ACCEPTANCE. King, N. M.; Simpson, P. W. (National Inst. for Research in Nuclear Science, Chilton (England)). Rutherford High Energy Lab.). June 1965. 20p. Dep. mn.

Ipso Facto is an Atlas Fortran program for computing acceptance as a function of momentum in high energy particle beams. Its chief features are outlined, and a detailed guide to its use is given. (auth)

13766 (TID-23521) LARGE-ORBIT ELECTRON SYNCHROTRON. Collins, T. L.; Livingston, M. S.; Rees, J. R.; Snyder, H. S. (Cambridge Electron Accelerator, Mass.). July 17, 1961. Contract AT(30-1)-2076. 26p. (CEA-88). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Plans in progress for AG proton accelerators in the 300 to 1000 BeV energy range involve circular underground tunnels of large radius and require major laboratory facilities. If such a machine is to be built, the possibility should be investigated of including an electron synchrotron of maximum possible energy in the same tunnel and sharing the facilities. An AG electron synchrotron of 50-BeV can be designed for a tunnel with radius adequate for a 400-BeV proton synchrotron. A design study of such a machine is presented. The major problem is the radio-frequency power to compensate for radiation loss, which has a peak value of 800 MeV per turn. Diaphragm-loaded waveguide units similar to those used for linacs could be located in gaps between magnets, occupying about one-third of the orbit. 320 units are proposed, each 20-ft. long, operating at 1000 Mc frequency. The AG magnets would be of small size and have low power requirements, and would operate at a cycling rate of 60 cps. A 1-BeV linear preaccelerator at 1000 Mc frequency would utilize components identical with the radiofrequency units. Total power requirements would not exceed that installed for the proton accelerator. (auth)

13767 (UCRL-17162) PARTIAL ENERGY BEAMS FROM AN ION LINAC. Ghiorso, A.; Hubbard, E. L.; Main, R. M.; Spence, D. A.; Voelker, F. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 15p. (CONF-661021-31). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

For the past few years the Heavy Ion Linear Accelerator (HILAC) at Berkeley has been accelerating partial-energy beams of various ions, with a resolution and an intensity comparable to the full energy beam of 10 MeV/nucleon. Energy levels are available from 3 MeV/nucleon up, in incremental steps corresponding to individual linac gap energies. Tuning is accomplished by varying the excitation of the drift-tube quadrupole magnets, and by changing the electric gradient distribution along the tank with LC wall tuners and adjustable end gaps. The particles appear to drop out of phase at the chosen gap with no subsequent acceleration. Results of typical particle beams are given, including discussion of energy spectra and rf structure. (auth)

13768 (BNL-tr-113) SURVEYING PROBLEMS ON THE GERMAN ELECTRON SYNCHROTRON (AT HAMBURG-GROSS FLOTTBEK). Marzahn, K. Translated for Brookhaven National Lab., Upton, N. Y., from Z. Vermessungswesen, 89: 251-60(1964). 20p. Dep. mn. JCL $1.80 fs, $0.60 mf.

After a brief discussion on the characteristics and operation of the German Electron Synchrotron, the problems of mensuration which arrived in construction are reviewed. Topics included are surveying instruments, survey octagon, positional and elevational changes in the survey octagon, positional and elevational changes in annular concrete beam and alignment of magnets. (B.G.D.)

13769 (BNL-tr-114) MENSURATION PROJECTS ON THE GERMAN ELECTRON SYNCHROTRON IN HAMBURG. Marzahn, K. Translated for Brookhaven National Lab., Upton, N. Y., from Reprint No. IFAG-Mitt.-64. 23p. JCL $2.60 fs, $0.89 mf.

The mensuration problems in setting up 48 electromagnets in the German Electron Synchrotron at Hamburg are described. Topics include precision standards, surveying instruments, survey octagon, and vertical orientation and measurements of elevation on a ring foundation. The parameters of the synchrotron are included. (B.G.D.)

13770 (SLAC-Trans-55) PRODUCTION OF MONOCHROMATIC γ RAYS IN AN ELECTRON STORAGE RING. Korobeinikov, L. S.; Kurdadze, L. M.; Onuchin, A. P.; Popov, S. G.; Tumaikin, G. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt (Stanford Linear Accelerator Center, Calif.), from Preprint 62. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.95 mf.

By isolating a narrow energy range in the bremsstrahlung spectrum, a beam of monochromatic γ-rays was produced in the electron storage ring VEP-I. The target and the counter for secondary electrons were located in the magnetic field of the storage ring. Measurements were performed at four electron energies (43, 70, 100, and 135 MeV) using targets of thickness equal to $1/20$ and $1/900$ of the radiation length. The γ-ray counting rate and the angular dimensions of the beam are in agreement with calculations. The γ-ray beam was used to calibrate the total absorption counters used in an experiment on double bremsstrahlung. (auth)

13771 (SLAC-Trans-60) SHIELDING FOR THE FRASCATI LINEAR ACCELERATOR QUENCH TANKS. Ladu, M.; Pellicioni, M.; Roccella, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Translated for Stanford Linear Accelerator Center, Calif., from report LNF-66/44. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The quench tanks provided for the 400 MeV (million electron-volt) beams of the Linac (linear accelerator) at Frascati are made up of cylindrical tanks full of water containing copper plates along the path of the cascade of nucleons. Thicknesses of concrete and of earth will be placed around the tank to attenuate the radiation produced. The necessary thicknesses to be used for a tank 1.8 meters long and having a diameter of one meter is evaluated. Only the attenuation of the neutron component which, at the energy levels dealt with, represents the most penetrating component is investigated. (auth)

13772 CAPTURE COEFFICIENT OF PARTICLES IN ACCELERATOR. Bakai, A. S. At. Energ. (USSR), 21: 503-4 (Dec. 1966). (In Russian).

As a result of friction and changes in the energy of the particles, the integral "separatrix" curve indicating the region of stable motion of particles in an accelerator cannot be represented by a closed line but by a family of curves which approaches asymptotically the equilibrium condition. In the calculation of the capture coefficient, it must be taken into account that acceleration or capture of a particle depends on its phase at the moment of incidence. Calculations carried out on that basis indicated that the conditions of the injection must be so chosen that the lower limit of the energy of the injected particles coincides with the lower boundary of the phase oscillation. The capture coefficient calculations must also take into consideration other degrees of freedom, such as the radial motion. The radius of the particle trajectory increases with the energy and at energies greatly exceeding the equilibrium value, the particle may collide with the wall. Therefore, if high capture cross sections are desired, the magnetic track width must be chosen that such particles will not hit the wall. (TTT)

13773 PREPARATION OF ISOTOPIC LEAD AND BISMUTH TARGETS FOR NUCLEAR INVESTIGATIONS. Medyanik, V. N.; Karev, V. N.; Klyucharev, A. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Kh., 11: 560-2(1966). (In Ukrainian).

An electrolytic bath containing the complexing agent Trilon B was examined as to its suitability for preparing isotopic targets. The metallic lead was dissolved in nitric acid, evaporated, and heated to 600 to 680°C, dissolving the yellow oxide formed in acetic acid. The crystallized lead acetate was then used to prepare the bath which contained 20 g/l Trilon B and had a pH between 4.5 and 4.9. A 20-μ-thick copper foil was used as a support for the deposition, removing it later with chromisulfuric acid. The deposition was carried out at a current density of 0.25 to 0.5 A/dm^2 with a lead anode. The shape and dimensions of the anode were found to affect the brilliance of the deposit. Uniform, nonporous lead layers were also obtained at higher current densities and at temperatures between 60 and 70°C. Foils of ^{206}Pb, ^{207}Pb, and ^{208}Pb were thus prepared. For the preparation of isotopically enriched bismuth foils, an electrolyte containing $BiCl_3$ was used in hydrochloric acid solution. The electrodeposition carried out at room temperature at a current density of 2.7 A/dm^2 yielded 2.0- to 10-μ-thick layers; a platinum cathode and a copper anode were used. (TTT)

13774 TRITIUM LOSSES IN LARGE ACCELERATORS. Jones, P. M. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 48: 351-2(1967).

Experience with the supply of tritium for use in large tandem accelerators has revealed that approximately 40 per cent is lost by sorbtion in the walls and materials of the accelerators, or by exchange with hydrogen isotopes present within the accelerator system. (auth)

13775 SUPPRESSION OF EXTRANEOUS BEAM PULSES. Ruby, L. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 48: 328(1967).

In certain low-voltage accelerators which have the ion source at high potential with respect to ground, such as Cockcroft-Walton accelerators, sparks in the vacuum system can be picked up as extraneous beam-on pulses. Such accelerators usually communicate beam-off and beam-on timing information to the high-voltage terminal via light pipes. If a spark results in turning on the beam during the normal off-time, the consequences can be very serious for any experiment which involves counting during the time between pulses. The essence of a method for solving this problem is to use an oscillator to continuously supply beam-off pulses during the time between beam pulses. Thus, any spark-induced beam pulse which appears during this period is quickly suppressed by the next beam-off pulse which comes along. (B.G.D.)

13776 WIDE RANGE VOLTAGE STABILIZER FOR A VAN DE GRAAFF ACCELERATOR. Brafman, H.; Goldring, G.; Tamari, D. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instrum. Methods, 48: 306-8(1967).

A new voltage stabilizer was developed for tandem Van de Graaff accelerators whose input signal is taken from generating voltmeter of the accelerator. When used in conjunction with the conventional stabilizer (whose signal is taken from the exit slit of the energy analyzing magnet) it effectively extends the dynamic range of the latter by restoring the accelerating voltage to the control range of the slit stabilizer after large deviations caused by discharges or other transients. This results in a more stable operation and prevents the slit stabilizer from selecting the wrong beam after such a transient. (auth)

13777 INVESTIGATIONS FOR A FFAG ELECTRON SYNCHROTRON OF THE RADIAL-SECTOR TYPE (END ENERGY ~150 MeV). IV. ON THE SELECTION OF OPTIMAL CHARACTERISTIC QUANTITIES AND HIGH-FREQUENCY PROGRAM FOR THE H-F ACCELERATION SYSTEM. Rudloff, W. (Freie Univ., Berlin). Nucl. Instrum. Methods, 48: 197-212(1967). (In German).

The influence of working point and geometry of the accelerator upon the characteristic quantities of the high frequency acceleration system are considered. The relative power requirement of the accelerating cavity is calculated. Optimal partition of the cavity with regard to power requirement and accelerating time and the possible repetition rates of the accelerating cycles are given. Time requirement and efficiency of several amplitude and frequency accelerating programs and the influence of beam stacking at intermediate energies upon the mean output current are calculated. The possible mean output current of the accelerator is estimated. (auth)

13778 INVESTIGATIONS FOR A FFAG ELECTRON SYNCHROTRON OF THE RADIAL-SECTOR TYPE (END ENERGY ~150 MeV). V. DESIGN AND PROPERTIES OF THE HIGH-FREQUENCY ACCELERATION SYSTEM. Rudloff, W. (Freie Univ., Berlin). Nucl. Instrum. Methods, 48: 213-18(1967). (In German).

A complete and variable model high-frequency accelerating system for a FFAG electronsynchrotron was developed and built up. The performance and properties of the system are given. The system satisfies to the requirements with regard to variability of accelerating programs, bandwidth, setting range of parameters and stability. (auth)

13779 CLASSICAL CONSIDERATION OF AN INDUCED RADIATION OF ELECTRONS IN INTERSECTING FIELDS. Pavlenko, Yu. G.; Galtsov, D. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1232-3(1966). (In Russian).

The induced emission of a nonrelativistic electron is calculated in crossed fields by a dipole approximation. The solution for the trajectory of motion of the electron in the crossed fields turns out to be an epitrochoid. The intensity of spontaneous radiation is then found by a dipole approximation at a solid angle $d\theta$ in a direction n. The instantaneous rate of induced radiation is then averaged over the phases of the field and the electrons, and an expression for the intensity of the induced radiation is found. The averaging depends on the physical conditions under which the emission takes place. Adsorption takes place at a frequency Ω_H. External emission becomes greater at a frequency Ω_E. (TTT)

13780 IMPROVEMENTS IN AND RELATING TO PARTICLE ACCELERATORS. (to CSF-Compagnie Generale de Telegraphie Sans Fil). British Patent 1,054,237. Jan. 4, 1967. Priority date Mar. 13, 1964, France.

A device is described which is intended to be used at the output of particle accelerators for shortening the pulses of the accelerated particles. (B.G.D.)

13781 IMPROVEMENTS IN AND RELATING TO DEVICES FOR ACCELERATING PARTICLES. (to N. V. Philips' Gloeilampenfabrieken). British Patent 1,052,651. Dec. 30, 1966. Priority date Apr. 18, 1963, Netherlands.

A cyclotron is described for obtaining a beam of charged particles of sharply defined energy, including a charged particle source which emits particles at an angle to the median plane so that the particles undulate about a spiral path, and a diaphragm having a gap arranged in the path which gap limits the axial width of the beam. (B.G.D.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 13638 and 13823.

13782 (AE-261) ATTENUATION OF NEUTRONS AND PHOTONS IN A DUCT FILLED WITH A HELICAL PLUG. Aalto, E.; Krell, A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1966. 24p. Dep. mn.

Neutron and gamma attenuation was studied in a cylindrical duct having a length-to-diameter ratio of 7 partly (36 vol %) filled by a helical (screw-like) plug with an adjustable number of turns. The total neutron leakage through the duct decreased by a factor of six from zero to 0.5 turn, and by an additional factor of three from 0.5 to 2 turns (saturation value). The leakage with less than 0.5 turn is governed by fast flux and above 0.5 turn by epithermal flux. It is observed that the attenuation calculation in a homogenized, infinite material combined with the predicted attenuation in a duct gives the measured saturation attenuation. The length coordinates used must be slightly modified in this case. The attenuation of gamma radiation in the saturation case (~3 turns) equals that predicted without the duct attenuation in a homogenized infinite material. (auth)

13783 (GEAP-5272) EVALUATION AND COMPILATION OF ^{239}Pu CROSS-SECTION DATA FOR THE ENDF/B FILES. Greebler, P.; Aline, P. G.; Hutchins, B. A. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 1966. Contract AT(04-3)-189. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An extensive evaluation of ^{239}Pu neutron cross-section data was made, and a set of recommended values was compiled for the Evaluated Nuclear Data Files (ENDF/B) being set up at Brookhaven National Laboratory. This work was done as part of the cooperative effort by the Cross Section Evaluation Working Group to put together an initial ENDF/B cross-section file that will include most of the materials that are important for reactor analysis. The recommended ^{239}Pu cross-section data extend in energy from thermal to 15 MeV. Recent experimental work, such as the Petrel bomb test data, and previously unreported theoretical work that provides a firm basis for the selection of resonance parameters in the unresolved resonance region are taken into account. Data sources are summarized and are followed by a complete documentation of the evaluation analysis and a listing of the selected data. (auth)

13784 (KAPL-P-3181) FLUX SYNTHESIS USING MODIFIED GREEN'S FUNCTION MODES. Hooper, R. J. (Knolls Atomic Power Lab., Schenectady, N. Y.); Becker, M. (Rennssalaer Polytechnic Inst., Troy, N. Y.). [1964]. Contract W-31-109-eng-52. 20p. (CONF-661001-39). DTIE.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

In the modal method of space-time reactor analysis, the neutron flux is approximated as a linear combination of known spatial functions, the coefficients being functions of time. A variety of methods for choosing the trial functions have been considered. Most types of modes which have been considered can be difficult and/or time-consuming to calculate, especially in complex geometries. In view of this, a set of trial functions was chosen which can be determined with a minimum of time and effort and which can adequately represent flux tilts in large reactors. Efforts were centered on modifications of the Green's function modes. A series of one-group, one-dimensional test problems was run to test the merits of these modes. In general, the agreement between the exact solution and that synthesized from the modified Green's function modes was good. (S.F.L.)

13785 (NP-16486) ESSAIS DE CIBLES DEUTEREES POUR LA PRODUCTION DE NEUTRONS. (Analysis of Deuterium Targets for Neutron Production). Breynat, G.; Dubus, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 1965. 17p. (In French). Dep. mn.

The neutron yield of Ti-Ag and Pd-Ag targets electrolytically charged with deuterium was investigated. The results showed that at the beginning of the bombardment with deuterons the thermally charged targets instantly emit neutrons at values equal to or higher than the mean value, but all the electrolytically charged targets give at the beginning very few neutrons. The Pd targets have a yield three to four times weaker than that of the Ti targets and of the same order as that of uncharged Ag targets. (J.S.R.)

13786 (NP-16499) ETUDE DE L'ANISOTROPIE NEUTRONIQUE D'UN BLOC DE GRAPHITE INHOMOGENE. (Neutronic Anisotropy of a Block of Inhomogeneous Graphite). Pailhes, M. A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 1965. 27p. (In French). Dep. mn.

The neutron anisotropy of a block of pierced graphite was measured in two configurations. In the first configuration the block was placed at the center of the pile. The results showed no gain in the thermal neutrons with manipulations of the block. There was, however, a gain in thermal neutrons of the pierced block with respect to plain blocks. There was then no detectable anisotropy. In a second series of experiments the block was placed on the surface of the pile. In this case no perturbation was created at the interior of the pile. Some anisotropy was detected. However, the results can not be dissociated from the experimental configuration used. (J.S.R.)

13787 (WAPD-TM-592) ESTIMATING OPTIMUM ACCELERATION PARAMETERS FOR USE IN THE SUCCESSIVE OVERRELAXATION AND THE CHEBYSHEV POLYNOMIAL METHODS OF ITERATION. Hageman, L. A.; Kellogg, R. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In using the successive overrelaxation iteration method, finding the optimum overrelaxation parameter ω_b is an important and often a difficult part of the problem. An iterative procedure performed prior to the overrelaxation iterations is described from which an adequate estimate for ω may be obtained in relatively short computer time. (auth)

13788 INVESTIGATION OF THE CIRCUIT AND CHOICE OF MAIN ELEMENTS OF THE ACCELERATING VOLTAGE SOURCE OF THE PULSE NEUTRON GENERATOR. Kiryanov, G. I. (S.C.A.E., Moscow). pp 365-71 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The basic theory of the circuit for a pulse-accelerating voltage source used for a controlled neutron generator is described. Requirements of certain elements of the equipment were determined. Experimental results are considered. (auth)

13789 GENERATION OF A BEAM OF POLARIZED MONOCHROMATIC NEUTRONS. Abov, Yu. G.; Aleshko-Ozhevskii, O. P.; Ermakov, O. N.; Yamzin, I. I. (Inst. of Crystallography, USSR). Kristallografiya, 11: 695-8(1966). (In Russian).

A radiofrequency technique was developed to produce a beam of polarized neutrons based on spin reorientation. The spin reorientation probability for the instrument has a value of 0.98 ± 0.02. (S.F.L.)

13790 THERMAL-NEUTRON FLUX PERTURBATION BY DYSPROSIUM-ALUMINUM FOILS IN WATER AND URANYL FLUORIDE-WATER SOLUTIONS. Shook, Donald F.; Bogart, Donald; Alger, Donald L.; Muller, Robert A. (Lewis Research Center, Cleveland). Nucl. Sci. Eng., 26: 453-61(Dec. 1966).

Thermal-neutron flux perturbation factors were measured for dysprosium-aluminum alloy foils in water and uranyl fluoride-water solutions. The foils are representative of a type widely used for thermal-neutron flux surveys. The measurements provide additional data for comparison with analytical calculations of foil perturbation factors in water. The uranyl fluoride-water solutions used comprise absorptive diffusion media different from water or graphite that have been studied exclusively in the past. The edges of the thicker dysprosium-aluminum foils used are a significant part of the total foil surface so that the data provide a test for several proposed edge corrections to perturbation factor calculations. The experimental perturbation factors are in good agreement with the predictions of published calculational methods except for the dimensionless generalization of Dalton and Osborn. (auth)

13791 ASYMPTOTIC AND TRANSIENT SPECTRA IN INCOHERENT MEDIA. Trikha, S. K.; Grover, P. S. (Univ. of Delhi). Nucl. Sci. Eng., 26: 447-52(Dec. 1966).

In the case of crystalline (coherent) moderators, it has been observed that the trapping of neutrons in the Bragg peaks greatly affects the decay of a neutron pulse from inside small assemblies and leads to a much larger value of the observed decay constant as compared to the theoretical limit. A theoretical study of the pulsed neutron problem in finite assemblies of incoherent solid moderators is reported. It is found that even in the absence of the trapped neutrons, it will take a very long time for the decay constant to approach the theoretical asymptotic limit $(\nu\Sigma_f)_{min}$. A study of transient spectra was also made in these assemblies. It is found that for large assemblies ($B^2 < B_c^2$), the value of λ calculated from the study of transient spectra agrees well with the

asymptotic decay constant. However, for small assemblies, the equilibrium is not attained within 600 μsec, the time limit of the studies. (auth)

13792 EXACT SOLUTION OF THE PROBLEM OF GOLDSTEIN AND COHEN. Horner, T. S.; Keane, A. (Wollongong Univ. Coll., New South Wales). Nucl. Sci. Eng., 26: 580(Dec. 1966).

Goldstein and Cohen postulated that the effective resonance integral consistent with an approximate integral for the flux can be exactly reproduced by admitting only a fraction (λ) of the scattering cross section of the absorbing nuclei. A numerical solution of the integral equation to obtain the effective resonance integral was performed; for the 192-eV resonance of ^{238}U in a 1:1 mixture of ^{238}U and hydrogen, a value of λ = 0.329 was obtained. (D.C.W.)

13793 REALITY OF RELAXATION LENGTHS IN VARIOUS APPROXIMATE FORMS OF THE SLAB TRANSPORT EQUATION. Gelbard, E. M.; Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 26: 569-71(Dec. 1966). (WAPD-T-1919).

It is proved that all double-P_l relaxation lengths are real if the differential scattering cross section is positive and that the relaxation lengths are real in all space-angle synthesis approximations and discrete-ordinate approximations. (D.C.W.)

13794 RECIPROCITY IN TIME-DEPENDENT NEUTRON TRANSPORT THEORY. Kuscer, I.; McCormick, N. J. (Univ. of Ljubljana, Yugoslavia). Nucl. Sci. Eng., 26: 522-9(Dec. 1966).

For time- and velocity-dependent neutron transport theory, a reciprocity theorem is discussed that expresses a symmetry property of point-source or plane-source solutions in systems of uniform temperature. As a consequence of the theorem, the coefficients in a decay-mode expansion are found to be the adjoints of the normalized modes. A long-time solution of the time-dependent albedo problem for a thick slab is derived from diffusion theory, with the aid of the reciprocity theorem. The reflected and transmitted net currents and angular densities are expressed in terms of the solution of the steady-state Milne problem. (auth)

13795 ITERATIVE SOLUTION OF THE NEUTRON SLOWING DOWN EQUATION. Dyos, M. W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Keane, A. Nucl. Sci. Eng., 26: 530-3(Dec. 1966).

The convergence of the iterative procedure for solving the slowing-down equation is examined. It is found that the rate of convergence of the iterative procedure depends on the ratio of the resonance scattering and absorption cross sections, being rapid if the resonance is predominantly absorbing. The method of Goldstein and Cohen for treating intermediate resonances is carried to the third approximation, and numerical results are obtained for the 192-eV resonance of ^{238}U in a 1:1 mixture with hydrogen. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 13128 and 13823.

13796 (ORO-2972-25) ANNUAL REPORT OF THE ACCELERATOR LABORATORY FOR 1966. (Texas Univ., Austin. Accelerator Lab.). Dec. 1966. Contract AT(40-1)-2972. 74p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The polarization of protons elastically scattered from ^{4}He was measured between 6.0 and 11.6 MeV; a phase-shift analysis of the data was performed. The differential cross sections and absolute polarizations for proton elastic and inelastic scattering by ^{9}Be were measured in the energy range from 7.0 to 11.0 MeV. The energy levels of ^{13}N were investigated using the polarization of protons elastically scattered by ^{12}C at 4 to 10 MeV. Neutron resonances were also observed in neutron elastic and nonelastic scattering by C at 13.5 to 24.5 MeV. Alpha angular distributions and yields from the reaction ^{12}C(d,α)^{10}B at 5 to 9.5 MeV were measured, as were differential cross sections for the reaction ^{13}C(d,α)^{11}B at 10 to 12 MeV. An attempt was also made to observe alpha cluster structure of ^{15}O using proton reactions and scattering on ^{14}N. The energy levels of ^{32}S were investigated using the reaction ^{31}P(p,α)^{28}Si at 1 to 5.7 MeV. Differential cross sections and yields for the reaction ^{31}P(d,α)^{29}Si at 5.5 to 12.0 MeV were measured, as were excitation functions for the (p,α) reaction on ^{35}Cl and ^{37}Cl at 4 to 7 MeV. The measurement of nuclear level spins using proton polarization from scattering was investigated; the polarization of protons scattered elastically by ^{90}Zr was measured. An experimental observation of the coupling of the (d,n) and (d,p) reaction channels was made by observing deuteron reactions with zirconium at 5 to 10 MeV. Isobaric analog states were observed in proton elastic scattering by ^{134}Te, ^{136}Te, ^{128}Te, and ^{130}Te; parameters were determined for a number of the analog resonances observed. Similarly, analog states in ^{209}Bi were investigated using proton scattering by ^{208}Pb. The effect of the electromagnetic interaction on isospin selection rules in nuclear reactions was studied theoretically, as was the polarization of protons from (d,p) reactions. Also, finite-range calculations were carried out for knockout reactions using the distorted-wave formalism. A facility for the production of Si surface-barrier detectors was put into operation, as was a computer system for on-line use with pulse analyzers at the tandem and 4-MeV Van de Graaff accelerators. (D.C.W.)

13797 TRITIUM YIELD OF THE REACTION ^{4}He(γ,p)^{3}H WITH 44 AND 54 MeV BREMSSTRAHLUNG. Buttlar, H. v.; Freund, F.; Gammel, G. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 200: 1-6(1967). (In German).

The photo disintegration of the α-particle was investigated by counting the tritium accumulated during irradiation with a low-level gas counting system. The measured yield is compared with values calculated from published cross-section data. (auth)

13798 ELECTROMAGNETIC FORM FACTORS OF ^{3}H AND ^{3}He WITH REALISTIC POTENTIALS. Gupta, V. K.; Bhakar, B. S.; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 153: 1114-26 (Jan. 20, 1967).

The charge and magnetic form factors of ^{3}H and ^{3}He were calculated on the lines of Schiff's analysis for the problem. The three-body wave functions used were previously derived in an exact fashion, using separable potentials involving central as well as tensor forces. These wave functions are all characterized by a small S'-state probability (~1%). The calculations of the form factors and their corresponding radii were carried out for pure s-wave forces and for tensor forces, using the potential parameters of both Yamaguchi and Naqvi. It was found that, whereas the agreement with experiment for pure s-wave forces is poor, the inclusion of tensor forces improves the results considerably, so that they fall short of experimental values by not more than about 10%, which is fully within the scope of hard-core effects. To account for the appreciable difference (~0.17 F) between the charge radii of ^{3}He and ^{3}H, a positive value is required for the slope of neutron charge distribution, which is in agreement with the recent analysis from inelastic electron-deuteron scattering. A reasonable value for this slope, deduced from deuteron-scattering data, however, accounts for only about 0.1 F of this difference in the two radii. The remaining difference of about 0.07 F could probably be ascribed to hard-core effects, electromagnetic violations of charge independence, and effects of exchange moments. (auth)

13799 PHASE-SHIFT ANALYSIS OF DEUTERON–ALPHA SCATTERING BETWEEN 10 AND 27 MeV. Darriulat, P.; Garreta, D.; Tarrats, A.; Arvieux, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A94: 653-62(1967).

A phase-shift analysis of various cross-section and polarization data in deuteron-alpha scattering is presented for incident deuteron energies ranging from 10 to 27 MeV. The S-, P- and D-waves are found to continue smoothly their low-energy behavior, but F- and G-waves become important. The interaction appears to be dominated by absorption, and a qualitative description of the data in terms of a very simple diffraction model is given. (auth)

13800 ELASTIC SCATTERING OF POLARIZED DEUTERONS FROM ^{4}He BETWEEN 18 AND 22 MeV. Arvieux, J.; Darriulat, P.; Garreta, D.; Papineau, A.; Tarrats, A.; Testoni, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A94: 663-72(1967).

Angular distributions of polarized deuterons scattered from ^{4}He are presented for 17.7-, 19.7- and 21.4-MeV incident energy. Experimental problems linked to the use of deuterons polarized before acceleration are discussed in detail. Vector and tensor polarization parameters are small and do not show important energy dependence. (auth)

13801 NON-COPLANARITY IN PROTON–PROTON BREMSSTRAHLUNG AT 157 MeV. Gottschalk, B.; Shlaer, W. J.; Wang, K. H. (Harvard Univ., Cambridge, Mass.). Nucl. Phys., A94: 491-501(1967).

The dependence on coplanarity of the reaction p + p → p + p + γ was investigated for outgoing protons at symmetric angles of 30 and 35° to the beam. The cross section falls off, approximately linearly, as the non-coplanarity of the final state approaches the limit set by kinematics. The coplanar cross sections at θ = 30 and 35° are 10.6 and 14.0 μb/sr^{2} ± 20%, respectively, consistent with previous results. (auth)

13802 THE PHOTODISINTEGRATION OF ^{3}He FROM A DIRECT CAPTURE MODEL OF THE D(p,γ)^{3}He REACTION. Bailey,

G. M.; Griffiths, G. M.; Donnelly, T. W. (Univ. of British Columbia, Vancouver). Nucl. Phys., A94: 502-12(1967).

Differential and total cross sections were obtained for the reaction $^3He(\gamma,p)D$ by applying the reciprocity theorem to results calculated for the reaction $D(p,\gamma)^3He$ on the basis of a simplified two-body direct radiative capture model. The proton-deuteron interaction is described by a square well plus Coulomb potential in both continuum and bound states. An attempt is made to relate the continuum wave functions used in the model to the p-d scattering data. Contributions from M1, E1, and E2 radiations are considered, and good agreement is found with recent experimental data from threshold to 40 MeV. The E1-E2 interference is found to be of importance even at low energies. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 13796, 13823, 13852, and 13910.

13803 (AD-639800) EXCITATION OF A 19-MeV LEVEL IN ^{12}C BY INELASTIC ELECTRON SCATTERING. Crannell, Hall; Dahl, Harvey A.; Lewis, F. H. Jr. (Stanford Univ., Calif. High-Energy Physics Lab.). Mar. 1966. Contracts Nonr-225(67); AF 49(638)-1389. 15p. (HEPL-432; ITP-206). CFSTI $3.00 cy, $0.65 mn.

Measurements of inelastic electron scattering cross sections for ^{12}C were made for transitions to a level at approximately 19.5 MeV. The cross section peak corresponding to excitation of this level is clearly visible above the inelastic continuum over the range of momentum transfers from 267 to 643 MeV/c at electron scattering angles between 40 and 48°. Form factors derived from the experimental data are compared to theoretical form factors calculated by assuming that the excitation involves a single-particle dipole transition to a T = 1, J = 1- state. A search for levels with higher excitation energies was also undertaken, special attention being focused on the region from 30 to 45 MeV. This failed to uncover, within the experimental sensitivity, any levels with excitation energy greater than 20 MeV. (auth)

13804 (ANU-P-372) THE ELASTIC SCATTERING OF ^3He BY ^{10}B AT 9.8 MeV. Patterson, J. R.; Poate, J. M.; Robson, B. A.; Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1966]. 6p. Dep. mn.

The angular distribution for the $^{10}B(^3He,^3He)^{10}B$ reaction was measured at 9.8 MeV, and optical-model parameters were determined. (auth)

13805 EXCITATION OF THE GIANT PHOTONUCLEAR RESONANCE BY THE (d,γ) REACTION IN LIGHT NUCLEI, IN PARTICULAR ^{11}B AND ^{16}O. Suffert, Martin (Univ., Strasbourg). Ann. Phys. (Paris), 1: 547-76(Sept.-Oct. 1966). (In French).

The radiative capture of deuterons by some light nuclei in the giant resonance energy region is described. An apparatus designed for the measurement of (d,γ_0) reactions in peculiar experimental conditions, especially with very low cross sections in a very strong background is described. The reactions $^9Be(d,\gamma_0)^{11}B$ and $^{14}N(d,\gamma_0)^{16}O$ were chosen as typical reactions. Absolute cross sections, excitation curves, and angular distributions were measured. Results of the $^9Be(d,\gamma_0)^{11}B$ reaction may be explained by a direct interaction mechanism for absolute values of cross sections as well as for the shape of the excitation curve. Measured angular distributions are not in contradiction with this hypothesis but a low asymmetry must still be explained. Study of the $^{14}N(d,\gamma_0)^{16}O$ reaction was performed to verify the isospin selection rule in a light nucleus. The results appear to disagree with this rule in the excitation energy and a hypothesis is advanced to explain this fact. ^{16}O follows a very peculiar behavior around 22 MeV. It is concluded that results from other types of reactions will be necessary to make this situation clear in this energy region. (auth)

13806 $^9Be(\alpha,2\alpha)^5He$ REACTION AND ALPHA-PARTICLE MODEL FOR ^9Be. Hiura, Jun; Shimodaya, Ichiro (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 36: 977-1002 (Nov. 1966).

Quasi-free $\alpha-\alpha$ knockout collisions in ^9Be are investigated by using the α-particle model, in order to test further the validity of the α-cluster picture in ^9Be and to clarify the reaction mechanism in terms of well established $\alpha-\alpha$ and $n-\alpha$ potentials. The α-particle model wave function of ^9Be is constructed on the basis of the above potentials and the exclusion principle procedure. Quasi-free $\alpha-\alpha$ scattering is treated in the impulse approximation. Off-the-energy shell effects are completely calculated. The effects of the broad resonant state of ^5He are also taken into account in terms of the final state $n-\alpha$ interaction. These features and the admixture of the excited states of the ^9Be core determine the angular correlation of the reaction products. The theory succeeds in explaining satisfactorily both the shape and the magnitude of the experimental angular correlation distribution at incident energies of 30 to 40 MeV. It is suggested that the experimental data at about 23 MeV are of particular interest. It is noted that these results are derived only from the actual nuclear forces and do not involve any free parameters. (auth)

13807 NATURE OF HARTREE–FOCK CALCULATIONS IN LIGHT NUCLEI. Bar-Touv, J. (Weizmann Inst. of Science, Rehovoth, Israel); Levinson, C. A. Phys. Rev., 153: 1099-1107 (Jan. 20, 1967).

The role of the two-body force, its exchange mixture, and the spin-orbit force in their effect on the Hartree-Fock wavefunctions and spectra is investigated. It is shown that the main features of the Hartree-Fock single-particle field are determined almost completely by the long-range part of the two-body force. The solutions for a long-range model are derived for various systems of different neutron excesses, and the exchange dependence of the energy "gap" between occupied and unoccupied levels is particularly considered. The main effect of the spin-orbit force and the finite range of the two-body force is to mix the orbitals. In the cases where the energy "gap" is large, the mixing is only of the occupied orbitals among themselves. Out of this study it emerges that the most natural representation for the Hartree-Fock single-particle orbitals is that associated with the axially symmetric deformed harmonic oscillator where one takes linear combinations of degenerate orbitals which are time-reversal eigenstates. This prescription results often in nonaxially symmetric nuclei and is consistent with the results found in exact calculations with realistic forces. (auth)

13808 PARITY OF THE 2.10- AND 1.08-MeV LEVELS IN ^{18}F. Poletti, A. R. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 153: 1108-13(Jan. 20, 1967). (BNL-10505).

The linear polarization of the 2.10-MeV γ ray, de-exciting the ^{18}F 2.10-MeV level, was measured. This, together with the mixing ratio recently determined by Gorodetzky et al. for this transition, fixes the parity of the 2.10-MeV level in ^{18}F as odd. Since the 1.08-MeV level in ^{18}F is known to have the same parity as the 2.10-MeV level, its parity is also fixed as odd. The structure of these two levels is discussed. The results are also reported of a separate experiment in which the mixing ratios of the 2.10 → 0-MeV and 2.10 → 0.94-MeV transitions were measured. (auth)

13809 STUDY OF REACTIONS INDUCED IN ^9Be BY 46-MeV PROTONS. Verba, J. W.; Willmes, H.; Carlson, R. F.; Slaus, I.; Richardson, J. Reginald; Petersen, E. L. (Univ. of California, Los Angeles). Contract Nonr 233-(44). Phys. Rev., 153: 1127-38(Jan. 20, 1967).

Reactions induced by the bombardment of ^9Be by 46-MeV protons were studied. Angular distributions were measured for ^9Be (p,p)^9Be (elastic scattering), $^9Be(p,p')^{9*}Be$ (2.43-MeV state), $^9Be(p,d)^8Be$ (ground state), $^9Be(p,d)^{8*}Be$ (2.90-MeV state), ^9Be (p,d)$^{8*}Be$ (16.93-MeV state), $^9Be(p,d)^{8*}Be$ (17.64-MeV state), $^9Be(p,d)^{8*}Be$ (18.15-Mev state), $^9Be(p,d)^{8*}Be$ (19.05-MeV state), $^9Be(p,t)^7Be$ (ground state), $^9Be(p,t)^{7*}Be$ (4.55-MeV state), ^9Be (p,t)$^{7*}Be$ (6.51-MeV state), and $^9Be(p,t)^{7*}Be$ (10.79-MeV state). (auth)

13810 FLUCTUATION STUDIES OF THE (α,p) REACTION ON ^{19}F, ^{23}Na, AND ^{31}P. Seaman, G. G. (Los Alamos Scientific Lab., N. Mex.); Leachman, R. B.; Dearnaley, G. Contract W-7405-eng-36. Phys. Rev., 153: 1194-1205(Jan. 20, 1967). (LA-DC-7958).

The (α,p) reaction for many angles between 0 and 175° was used for fluctuation studies with the target nuclei ^{19}F, ^{23}Na, and ^{31}P. The incident energies were 5.2 to 8.0 MeV, 5.9 to 7.9 MeV, and 13.0 to 15.7 MeV; and the measured coherence widths were 50, 35, and 33 keV, respectively. Cross-section peaks were unusually correlated between yields at different angles and between yields to different final states for 5.2- to 5.6-MeV alpha-particle energy on ^{19}F; only data above 5.6 MeV were analyzed for fluctuations for this target. The resulting sample sizes in the analyses were then 17, 20, and 27, respectively. Calculations of the effective number of sets of angular-momentum projections damping the fluctuations in the cross sections were used at all angles to determine the additional damping that results from the fraction of direct reactions. For the most forward angles, 0 to 30°, the fraction of direct reactions was generally found to be less than $\frac{1}{2}$ for the ground-state reactions and about 0.6 for the first-excited-state reactions. Even though the data were analyzed for the whole span of energies measured, the modest sample sizes available in these studies resulted in large uncertainties in determining these fractions of direct reactions. Nevertheless, the measured cross sections were in qualitative agreement with both distorted-wave Born-approximation calculations of the direct-reaction cross

sections and Hauser-Feshbach calculations of the compound-nucleus cross sections. (auth)

13811 ANALYSIS OF THE INTERMEDIATE STRUCTURE OBSERVED IN THE NEUTRON CROSS SECTION OF ^{19}F. Monahan, J. E.; Elwyn, A. J. (Argonne National Lab., Ill.). Phys. Rev., 153: 1148-51(Jan. 20, 1967).

In measurements of the angular distribution and polarization of neutrons scattered from ^{19}F at neutron energies between 0.2 and 2.2 MeV, resonances are observed to have widths that are larger than the widths usually associated with states of the compound nucleus but are considerably smaller than the widths of single-particle resonances. A phase-shift analysis of these data is shown to be consistent with the interpretation of this intermediate structure in terms of doorway states. (auth)

13812 NUCLEAR POLARIZATION IN THE $^{11}B(d,p)^{12}B$ REACTION. I. Berlijn, J. J.; Keaton, P. W. Jr.; Madansky, L.; Owen, George E.; Pfeiffer, Loren; Roberson, N. R. (Johns Hopkins Univ., Baltimore). Phys. Rev., 153: 1152-8(Jan. 20, 1967).

Measurements of the polarization of the ^{12}B recoils produced in the $^{11}B(d,p)^{12}B$ reaction were made using a variety of recoil stopping materials. A lower limit of $P \geq +0.0436 \pm 0.0021$ is set for the recoil polarization in the direction of $k_d \times k_p$ at $E_d = 3.1$ MeV and 53° recoil angle. (auth)

13813 HIGHER RANDOM-PHASE-APPROXIMATION STUDIES OF THE STRUCTURE OF ^{16}O. I. Philpott, R. J.; Szydlik, P. P. (Univ. of California, Davis). Phys. Rev., 153: 1039-51(Jan. 20, 1967).

The energy spectrum of ^{16}O was investigated theoretically using the basic functions of the nuclear (harmonic-oscillator) shell model. Random-phase-approximation (RPA) techniques are used to decouple the core state from the excited configurations, thereby overcoming the problem of the exaggerated ground-state depression found in standard shell-model calculations. The general equations of the higher RPA are reduced to a more restricted but tractable form which contains both the Tamm-Dancoff approximation and the standard (first) RPA as special cases. For the even-parity states, it is found that the resulting secular equation reduces in good approximation to that of a shell-model calculation with the core state removed. Interaction matrices between all one-hole one-particle and two-hole two-particle states at $1\hbar\omega$ and $2\hbar\omega$ excitation were diagonalized to obtain the level structure of ^{16}O in the absence of spurious states of center-of-mass motion. A Gaussian central force with Rosenfeld exchange was employed, the strength being determined by a rough fit to the lowest $J = 0+$ and $2+$, $T = 0$ levels. Despite the restricted nature of this fit, a remarkably good agreement between the calculated and observed energy spectrum is obtained. The $T = 0$ spectrum is well represented apart from two states (with $J = 4+$ and $6+$) which are calculated below the lowest corresponding observed levels. Moreover, the $T = 1$ states of both parities fall correctly in relation to each other and to the fitted states, and the $T = 2$ states as well reproduced. (auth)

13814 ENERGY LEVELS OF ^{19}Ne. Greene, M. W.; Nelson, E. B. (Univ. of Iowa, Iowa City). Phys. Rev., 153: 1068-71 (Jan. 20, 1967).

The reaction $^{20}Ne(^3He,\alpha)^{19}N$ ($Q = 3.702$ MeV) was used to determine the energy of excited states of ^{19}Ne up to an excitation of 5 MeV. A thin surface-barrier detector was mounted inside a differentially pumped gas target chamber and measurements were made at ^3He bombarding energies of 5.90 and 6.00 MeV. Alpha-particle groups were measured at lab angles of 130, 145, 165, and 167.5°. Six kinematically consistent groups are assigned to ^{19}Ne. The excitation energies thus determined for the levels of ^{19}Ne are 4.013, 4.152, 4.344, 4.547, 4.689, and 5.077 MeV, where the probable uncertainty is ±15 keV. These previously unreported levels are found to correspond closely with levels of the mirror nucleus ^{19}F. (auth)

13815 DECAY OF ^{12}N. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H. Contract AT(30-2)-Gen-16. Phys. Rev., 153: 1061-7(Jan. 20, 1967). (BNL-10504).

Positron-gamma coincidence measurements were carried out on ^{12}N by forming the activity in the $^{10}B(^3He,n)^{12}N$ reaction using a mechanically chopped Van de Graaff beam of 3.4-MeV He^{2+} ions and by detecting the delayed positron and gamma radiations in plastic and NaI(Tl) scintillation detectors. Gamma rays with energies of 4.43, 12.7, and 15.1 MeV were observed in coincidence with positrons. For the two higher states, the ^{12}N positron branches and log ft values derived are $2.9 \pm 1.3 \times 10^{-3}$, log ft = 3.55 ± 0.16 for positron emission to the 12.71-MeV state of ^{12}C, and $4.4 \pm 1.5 \times 10^{-5}$, log ft = 3.32 ± 0.13 for the positron transition to the 15.11-MeV state of ^{12}C. (auth)

13816 GIANT DIPOLE STATES AND EXCITED GIANT DIPOLE STATES IN ^{12}C. Kamimura, M.; Ikeda, K.; Arima, A. (Tokyo Univ.). Nucl. Phys., A95: 129-60(1967).

The giant resonance observed in the reaction $^{11}B(p,\gamma_0)^{12}C$ and the excited giant resonance observed in the reaction $^{11}B(p,\gamma_1)^{12*}C$ (2^+ at 4.43 MeV) are studied. A coupling of the quadrupole vibration with the dipole oscillation is taken into account in a calculation based on the Tamm-Dancoff approximation, and this coupling is found to play an essential role in explaining these two reactions. Characteristics of these two reactions and correlations between them are reproduced very well by the model. Especially a considerably large peak at 25.5 MeV of an excitation energy in the reaction $^{11}B(p,\gamma_0)^{12}C$, which could not be predicted by previous studies, is explained by the result of the coupling described above, and it is made clear why there is a correlation between this peak and the main peak in the reaction $^{11}B(p,\gamma_1)^{12*}C$. Further, it is explained that the angular distribution is independent of excitation energy in the two reactions. (auth)

13817 FAST NEUTRON SCATTERING FROM BERYLLIUM, SODIUM, AND ALUMINUM. Chien, J. P. (Univ. of Michigan, Ann Arbor. Tsing Hua Univ., Shinchiku, Taiwan); Smith, A. B. Nucl. Sci. Eng., 26: 500-10(Dec. 1966). (TID-22777).

Essentially monoenergetic neutrons were scattered from Be, Na, and Al at incident neutron energy intervals of ≈50 keV throughout the range 0.3 to 1.5 MeV. Fast neutron time-of-flight techniques were employed to measure the elastically and the inelastically scattered neutron angular distributions. Differential elastic cross sections were determined, and the inelastic excitation cross sections of states in Al at 0.84 and 1.01 MeV, and in Na at 0.44 MeV were measured. In addition, the total cross section of Al was measured from 0.3 to 1.5 MeV with resolutions of ≳1 keV. The experimental results are related to the optical model and the Hauser-Feshbach theory of reaction processes. It is shown that these theoretical concepts can describe the scattering processes in Na and Al despite the marginal applicability of the theories to these light nuclei. (auth)

13818 ELASTIC SCATTERING OF 29-MeV ^3He BY COMPLEX NUCLEI. Baugh, D. J.; Pyle, G. J. B.; Rolph, P. M.; Scarrott, S. M. (Univ. of Birmingham, Eng.). Nucl. Phys., A95: 115-28(1967).

Differential cross sections of 29 MeV ^3He nuclei elastically scattered by C, Mg, Al, Si, Ca, ^{56}Fe, ^{63}Cu, Zn, Y, Ag, In and Sn in the angular range 15°–110°(lab) are presented, and discussed in terms of the optical model. (auth)

13819 A PROJECTED HARTREE–FOCK CALCULATION FOR ^{12}C. Bouten, M. (Studiecentrum voor Kernenergie, Mol, Belg.); Van Leuven, P.; Depuydt, H. Nucl. Phys., A94: 687-97 (1967).

An approximate projected Hartree-Fock calculation for ^{12}C is carried out. An increase of 11 MeV in the binding energy can be obtained by admixing 0d and 0f oscillator states to the orbitals. These admixtures enhance the E2 transition from the first excited state to the ground state and bring it in agreement with the experimental value. (auth)

13820 ON THE LOW-LYING STATES OF ^{16}O. Bottino, A.; Carazza, B. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 46B: 137-42(Nov. 11, 1966).

The form factors for monopole and quadrupole transitions in the low-energy spectrum of ^{16}O were calculated. Only the longitudinal (Coulomb) form factors which represent the only nonvanishing terms in monopole transitions and dominate the transverse terms in the E2 transitions, if the scattering angles are not too large, were evaluated. (D.C.W.)

13821 A FORTRAN PROGRAMME FOR THE IDENTIFICATION OF HYPERNUCLEI. Gajewski, W. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Univ. Brux., Inst. Phys., Bull. No. 29, 1-107(Nov. 1966).

A computer program for the kinematical analysis of the production and decay of hypernuclei in nuclear emulsions is described. Mesonic or nonmesonic decays at flight or in rest and the production of hypernuclei by meson (K^-) or hyperon (Σ^-) reactions with light nuclei can be treated, and joint analysis of decay and production can be performed. The program is written in FORTRAN IV for the IBM 7040 computer. (D.C.W.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 12439, 13796, 13857, and 13893.

13822 (ANU-P-374) ENERGY LEVELS OF ^{23}Na. Hay, H. J.; Kean, D. C. (Australian National Univ., Canberra. Research School of Physical Sciences). Oct. 11, 1966. 7p. Dep. mn.

Many previously unreported levels in ^{23}Na were found by magnetic analysis of the α particles from the ^{25}Mg(d,α)^{23}Na reaction using a Buechner spectrograph. (auth)

13823 (IITRI-1193-53(Vols.1 and 2)) PROMPT GAMMA RAYS FROM RADIATIVE CAPTURE OF THERMAL NEUTRONS. VOLUMES 1 AND 2. Final Report. Greenwood, R. C.; Reed, J. H. (IIT Research Inst., Chicago, Ill.). Oct. 14, 1965. Contract AT(11-1)-578. 906p. (IITRI-578P11-53(Vols.1 and 2)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An atlas of thermal neutron capture gamma-ray spectra measured under standard conditions using NaI(Tl) scintillation detectors and a comprehensive compilation of the neutron capture gamma-ray data which were available prior to May 1965, are presented. Included are prompt gamma-ray spectra and data from 74 naturally occurring elements, together with a number of separated isotopes, unstable elements, and fissionable materials. The objective of the report is to provide sufficient data concerning neutron capture gamma-ray spectra to allow evaluation of practical uses of an analytical technique based upon the detection of neutron capture gamma rays in measurement, analysis, and control technology and thereby to facilitate the use of the method in these areas. (auth)

13824 (PUC-937-220) THE J = 3/2 EXCITED STATES OF ^{41}Ca AND ^{41}Sc. Gerace, W. J.; Green, A. M. (Princeton Univ., N. J. Palmer Physical Lab.). July 1966. Contract AT(30-1)-937. 5p. (CONF-660906-29). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

A model is proposed for the J = 3/2 levels of ^{41}Ca and ^{41}Sc, in which the shell-model state is mixed with a deformed (3p-2h) state. Using this model a satisfactory explanation can be obtained for the single-particle strengths in the J = 3/2 levels, and also of their decay to the ground state. (auth)

13825 CROSS SECTIONS OF THE (n,p) AND (n,α) REACTIONS INDUCED IN MANGANESE BY 14.7-MeV NEUTRONS. Minetti, B.; Pasquarelli, A. (Politecnico, Turin). Z. Phys., 199: 275-9 (1967).

Manganese was irradiated with 14.7-Mev neutrons. By the technique of detecting induced β activity in the target material, $\sigma_{n,p} + \sigma_{n,\alpha}$ for the reactions induced in ^{55}Mn was measured. By detecting induced γ activity, $\sigma_{n,\alpha}$ was measured. The cross section $\sigma_{n,p}$ was determined from the difference of the two measurements. (auth)

13826 CORIOLIS-COUPLING MODEL PREDICTION OF MOMENTS AND TRANSITION RATES FOR DEFORMED ODD NUCLEI IN THE 1f$_{\frac{7}{2}}$ SHELL. Scholz, W.; Malik, F. B. (Yale Univ., New Haven). Phys. Rev., 153: 1071-6(Jan. 20, 1967).

The magnetic dipole and electric quadrupole moments and reduced transition probabilities were calculated for the Coriolis-coupling model using wave functions obtained previously. These wave functions were obtained from a linear combination of the ten rotational bands based on the ten available single-particle and core excited states in the 1f-2p shell, and the corresponding eigenvalues were consistent with the observed level spectra of the odd nuclei in the 1f$_{\frac{7}{2}}$ shell. The moments and transition rates predicted here are also in good agreement with experiment. Thus, the observed magnetic moments can no longer be considered as evidence supporting the validity of solely the spherical shell model for these nuclei. Contributions to the magnetic moment from single-particle terms and from cross terms between the bands are found to be important and have been included. The observed inhibition of the M1 transitions (which are allowed in the collective model) is a consequence of the strong band mixing which results in strong cancellation between the contributions from the direct and cross terms. The good agreement between the predicted and observed values of the quadrupole moments and B(E2) values has been achieved using the free proton charge of unity and neutron charge of zero. The contribution to the quadrupole moment from the single-particle term is found to be important, and on occasion constitutes as much as 50% of the total quadrupole moment. Furthermore, the collective spectroscopic quadrupole moment, with proper inclusion of the contribution from different bands, in some cases has a different sign from the intrinsic quadrupole moment. Proper inclusion of the contributions to the quadrupole moment from different bands and of the single-particle term leads to the important result that odd nuclei may yet have a very small quadrupole moment despite having large deformations. (auth)

13827 ^{38}K DECAY AND T = 1 ANALOG IN ^{38}Ar. Berg, R. E.; Snelgrove, J. L.; Kashy, E. (Michigan State Univ., East Lansing). Phys. Rev., 153: 1165-8(Jan. 20, 1967).

The 23-MeV proton beam from a sector-focused cyclotron was used to produce the ^{38}K isotope by means of the ^{38}Ar(p,n)^{38}K reaction. From measurements of γ rays following the positron decay of ^{38}K, the half life of ^{38}K was measured to be 0.265 ± 0.025 sec; and energy levels in ^{38}Ar were measured at 1.9701 ± 0.0007, 4.1779 ± 0.0007, 4.4401 ± 0.0012, and 6.6119 ± 0.0009 MeV. The 6.6119-MeV level is identified as the T = 1 analog of the ground states of ^{38}Cl and ^{38}K. Branching ratios for the positron decay of ^{38}K were obtained, and the log ft values were calculated for each branch, using the observed partial half life and a computed value of the ^{38}K mass. Spin and parity assignment of 2+ were made for the ground state of ^{38}K and the T = 1 level of ^{38}Ar, in agreement with the expectation from the previously measured 2+ value of the ^{38}Cl ground-state spin. (auth)

13828 NUCLEAR LEVEL-DENSITY FLUCTUATIONS AND TESTS OF THE COMPOUND STATISTICAL MODEL. Johnson, R. R.; Hintz, Norton M. (Univ. of Minnesota, Minneapolis). Phys. Rev., 153: 1169-85(Jan. 20, 1967).

Inelastic proton and alpha spectra were observed from (p,p') and (p,α) reactions on ^{58}Ni, ^{60}Ni, ^{63}Cu, ^{65}Cu, ^{64}Zn, and ^{66}Zn at bombarding energies around 10 MeV. ^{63}Cu and ^{66}Zn inelastic proton yield curves for bombarding energies ranging from 9.5 to 10.5 MeV indicate possible intermediate- or doorway-state resonance structure. Nuclear temperatures T were determined for the residual nuclei in these reactions from plots of $\ln[(d^2\sigma/d\epsilon d\Omega)/\epsilon\sigma_c]$ versus outgoing-channel energy ϵ (where σ_c = inverse cross section), and were found to agree with temperatures from N(U) or Ericson plots (direct level counts) when the temperatures were obtained from nearby excitation regions. Using the level-density formula $\rho(U) = [(1/T)\exp(U-\Delta)/T]$, where U is the residual nuclear excitation, the energy gap Δ was calculated from (p,p')-to-(p,α) yield ratios and found to agree with Δ's obtained from N(U) plots or from Cameron's pairing-energy tables. Departures or fluctuations in the number of levels in an energy interval δU were determined from yield fluctuations and compared with fluctuations predicted from Gaussian probability distributions with variances calculated from several theoretical level-spacing distributions. A Wigner spacing distribution, applicable to nuclear spectra, implies a level-number variance of 0.27 $\bar{N}$, where $\bar{N}$ + 1 is the average number of levels in an energy interval δU. Analysis of the experimental fluctuations gave a variance of K$\bar{N}$, where $0.1 \leq K \leq 0.3$. The method was inverted for high-resolution level-count data to determine T and the energy-gap parameter Δ, which in turn determines the absolute value of the level density. The level-count data showed $K \simeq 0.2$. (auth)

13829 ENERGETICS OF NUCLEON AND PHOTON EMISSION FROM COMPOUND NUCLEI: ANGULAR DISTRIBUTIONS OF ^{61}Cu RECOIL PRODUCTS. Kaplan, Morton; Subrahmanyam, V. (Yale Univ., New Haven). Phys. Rev., 153: 1186-93(Jan. 20, 1967).

The results obtained from a detailed study of the ^{55}Mn(^{11}B,p4n)^{61}Cu reaction are presented. The excitation function has a maximum cross section of about 130 mb at an energy corresponding to 6.2 MeV of available energy per nucleon emitted and is in good agreement with the compound-nucleus reaction mechanism inferred earlier on the basis of recoil-range data. Angular distributions of ^{61}Cu were measured at 10 bombarding energies over the region 53 to 114 MeV, covering all but the lowest-energy portion of the excitation function. These experiments were analyzed to yield information on the average total energies of particles and photons emitted in the de-excitation of the compound nuclei. Above about 20 MeV of available energy, gamma emission becomes significant and accounts for about 14 MeV of de-excitation energy at the higher bombarding energies. The amount of energy dissipated as gamma radiation is larger than nucleon binding energies and indicates substantial competition between particle and photon emission in the de-excitation process. The results are in very good agreement with other less specific but more direct gamma-ray measurements. (auth)

13830 ^{46}Ca(^{3}He,d)^{47}Sc REACTION. Schwartz, J. J. (Univ. of Rochester, N. Y.); Alford, W. Parker, Marinov, A. Phys. Rev., 153: 1248-52(Jan. 20, 1967). (UR-875-163).

The level structure of ^{47}Sc was studied by means of the ^{46}Ca (^{3}He,d)^{47}Sc reaction. Thirty-three levels were observed up to an excitation of 7.5 MeV in ^{47}Sc. Angular distributions were measured and were compared with distorted-wave Born approximation calculations to obtain values of the orbital-angular momentum transfer and spectroscopic factors. All of the f$_{\frac{7}{2}}$ strength and part of the p$_{\frac{3}{2}}$ and p$_{\frac{1}{2}}$ strength are observed, but no more than 30% of the total f$_{\frac{7}{2}}$ strength is observed below an excitation of 7.5 MeV. (auth)

13831 INTERACTIONS OF 22-MeV ^{3}He PARTICLES WITH ^{56,58}Fe AND ^{58}Ni. Flynn, Edward R.; Rosen, Louis (Los Alamos

Scientific Lab., N. Mex.). Phys. Rev., 153: 1228-47(Jan. 20, 1967). (LA-DC-7724).

A systematic study is made of the interaction of 22-MeV ^{3}He ions with ^{56}Fe, ^{58}Fe, and ^{58}Ni. The central purpose of this study is to compare the interactions induced by this strongly absorbed, spin-½ particle to various theoretical interpretations which have been successfully applied to the more commonly used nuclear probes: neutrons, protons, and alpha particles. The present investigation encompasses elastic and inelastic scattering as well as the spectral distribution of emitted neutrons of energy greater than 0.5 MeV. The elastic-scattering data are analyzed both in terms of an optical model and a strong-absorption model. The inelastic-scattering data and the high-energy neutron data are compared with the predictions of distorted-wave Born-approximation calculations. Finally, the low-energy neutron data are analyzed within the framework of the compound-nucleus model, and nuclear temperatures are extracted. (auth)

13832 ANALOG-STATE RESONANCES IN THE ^{89}Y(p,n)^{89}Zr AND ^{88}Sr(p,n)^{88}Y REACTIONS. Lightbody, D. B.; Sayres, A.; Mitchell, G. E. (Columbia Univ., New York). Phys. Rev., 153: 1214-20(Jan. 20, 1967).

Several compound-nucleus analog states formed in the reactions ^{89}Y(p,n)^{89}Zr and ^{88}Sr(p,n)^{88}Y were studied using a ^{3}He-filled proportional counter as a neutron spectrometer. 0° excitation curves and angular distributions were measured for both reactions. One striking feature of this data is the complete absence of the 5.02-MeV (3$^-$) resonance from the excitation curve for neutrons to the first excited state of ^{89}Zr. Most of the off-resonance data agree well with Hauser-Feshbach calculations, although there is some evidence for interference effects in the angular distributions measured near the 4.82-MeV resonance in the ^{89}Y(p,n)^{89}Zr reaction. Energy levels in ^{89}Zr were determined to be 0, 590, 1105, 1470, 1645, and 1880 keV. (auth)

13833 STUDY OF THE ^{31}P(α,$d_{0,1}$)^{33}S REACTIONS AT 18.7 MeV. Srivastava, B. B.; Cosper, S. W.; Johnson, O. E. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1420. Phys. Rev., 153: 1221-7(Jan. 20, 1967). (COO-1420-125).

The 18.72-MeV differential cross sections for the ^{31}P(α,d)^{33}S reactions leading to the ground and 0.841-MeV states of ^{33}S were measured from 15 to 170° at 5° intervals. The deuteron spectra were determined using a spectrometer configuration which incorporated an E × ΔE mass identification system and an (E, ΔE) counter telescope consisting of two silicon surface-barrier detectors. The target was prepared by the thermal vacuum evaporation of red phosphorus (650 ± 12 μg/cm^2) onto a thin Formvar film (~20 μg/cm^2). In contrast to the well-defined oscillatory shape of the angular distribution associated with the transition to the 0.841-MeV state, that corresponding to the transition to the ground state has only washed-out undulations. The integrated cross sections for the ground and 0.841-MeV state reactions are 724 ± 16 μb (16.9°–171.3°) and 425 ± 10 μb (17.0 to 171.3°), respectively. An analysis of the data in the distorted-wave Born approximation has been made in terms of a zero-range, knock-out model in which the initial (final) nuclear state is represented as a two-body system with a deuteron (alpha particle) bound to a ^{29}Si core. Good agreement between the experimental and theoretical angular distributions was achieved. The analyses require a $2s_{\frac{1}{2}}$ state for the (d,^{29}Si) system representing the ground state of ^{31}P, and $1d_{\frac{3}{2}}$ and $2s_{\frac{1}{2}}$ states for the (α,^{29}Si) system representing the ground and 0.841-MeV states of ^{33}S, respectively. An interpretation of the experimental results on the basis of the dominant shell-model configurations for the states of ^{31}P and ^{33}S yields the conclusion that there is no enhancement of the transition in which the members of the transferred nucleon pair enter equivalent orbitals relative to that in which the nucleons enter nonequivalent orbitals. (auth)

13834 PROPERTIES OF LOW-LYING STATES IN ^{44}Sc. Ristinen, R. A.; Sunyar, A. W. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 153: 1209-13 (Jan. 20, 1967). (BNL-10499).

A study was made of the properties and decay modes of the 146- and 68-keV excited states of ^{44}Sc populated by electron capture in ^{44}Ti. Relative 78-, 68-, and 146-keV γ-ray intensities are found to be 106.2, 100, and 0.10, respectively. Absolute K-shell internal conversation coefficients $\alpha_{78}^K = 0.123 \pm 0.023$ and $\alpha_{78}^K = 0.031 \pm 0.005$ were determined. The g factor of the 68-keV state was measured by a magnetically perturbed γ-γ angular-correlation experiment to be +0.342 ± 0.006. E2 admixtures $Q_{68} = (7.0 \pm 2.0)\%$ and $Q_{78} \leq 1.2\%$ were deduced from γ-γ angular-correlation results and the conversion measurements. A 1.9 ± 1.5% electron-capture branch to the 68-keV state was observed. Spin and parity assignments of 1+, 1+, and 2+ are most probable for the 146-keV, 68-keV, and ground states of ^{44}Sc. A remarkably large hindrance factor (≥6.6 × 10^9) is determined for the 146-keV M1 transition. All other M1 and E2 transition rates are strongly hindered except for the E2 component of the 68-keV transition, for which an enhancement of 16 is observed. (auth)

13835 COINCIDENCE STUDY OF THE REACTIONS ^{39}K(n,pγ)^{39}Ar AND ^{39}K(n,αγ)^{36}Cl. Bass, R.; Saleh-Bass, Fatma M. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Nucl. Phys., A95: 38-64(1967).

The reactions ^{39}K(n,p)^{39}Ar and ^{39}K(n,α)^{36}Cl were investigated by bombarding a KI(Tl) scintillator with fast monoenergetic neutrons in the energy range from 4 to 8 MeV. Information on the level and decay schemes of the final nuclei, especially ^{39}Ar, was obtained by spectroscopy of γ radiation in coincidence with protons and α particles. For the strongly populated final states ^{39}Ar* = 1.27, 1.52, and 2.10 MeV and ^{36}Cl* = 0.79 MeV, absolute excitation functions and γ angular distributions were measured and analyzed for spectroscopic information assuming a compound-nucleus reaction mechanism. The experimental techniques are described, and the results are discussed together with information available from other reactions leading to the same final nuclei. (auth)

13836 THE DECAY OF ^{56}Co. Huguet, Michel; Forest, Hugues; Ythier, Christian (Univ., Nice). Compt. Rend., Ser. B, 263: 1342-5(Dec. 7, 1966). (In French).

The γ radiation of ^{56}Co was studied with a pair spectrometer using as the central detector a Ge n-i-p diode. Several previously unreported γ rays and a previously unreported level of ^{56}Fe formed in this decay were detected. (tr-auth)

13837 STUDY OF THE ANGULAR DISTRIBUTION OF THE (n,α_0) REACTION ON ^{32}S FOR NEUTRONS OF 4 AND 5.1 MeV. Billerey, Roland; Chambon, Bernard; Salin, Raymond; Depraz, Jean (Univ., Lyon). Compt. Rend., Ser. B, 263: 1339-41(Dec. 7, 1966). (In French).

The angular distributions of the (n,α_0) reaction on ^{32}S at 4 and 5.1 MeV were determined using junction detectors. There is little variation in these distributions from 2.5 to 5.1 MeV. (tr-auth)

13838 DECAY OF THE 1.5 MIN ^{54m}Co ISOMER. Wegener, Dietrich (Univ., Goettingen, Ger.). Z. Phys., 198: 251-62(1967). (In German).

The ^{54m}Co($T_{\frac{1}{2}}$ = 1.43 min) was produced in iron foils by irradiation with 19-MeV deuterons. The gamma spectrum was investigated using a NaI(Tl) scintillation spectrometer, a coincidence circuit, and a Ge(Li)-counter. Three gamma rays having the following energies and intensities per ^{54m}Co decay were observed: 411 keV (0.97 ± 0.07), 1130 keV (0.98 ± 0 05), and 1407 keV (1.00 ± 0.05). The directional correlation between the pairs of gamma rays were determined. These results correspond to spin and parity $J^\pi = 2^+$ for the 1407-keV energy level, $J^\pi = 4^+$ for the 2537-keV energy level, and $J^\pi = 6^+$ for the 2948-keV energy level of ^{54}Fe. The latter level was not excited in previous scattering experiments. The results are compatible with E = 210 keV and $J^\pi = 6^+$ or 7^+ of the isomeric state of ^{54m}Co. (auth)

13839 RADIATIVE CAPTURE CROSS SECTIONS FOR 14.7-MeV NEUTRONS. Csikai, J.; Petoe, G.; Buczko, M.; Miligy, Z.; Eissa, N. A. (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Nucl. Phys., A95: 229-34(1967).

Radiative capture cross sections for 14.7-MeV neutrons were measured for 17 nuclei between A = 23 and 209. Excitation functions in the range E_n = 13.4 to 15.0 MeV were measured for six of these nuclei. A plot of $\sigma_{n,\gamma}$ against the target neutron number shows minima at the magic neutron numbers. The excitation functions suggest collective capture in (n,γ) reactions. The spin cutoff parameter was estimated from the isomeric cross-section ratio for neutron capture in ^{103}Rh. (auth)

13840 SCATTERING OF POLARIZED NEUTRONS BY INTERMEDIATE AND HEAVY NUCLEI. Mahajan, A. S. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Nucl. Phys., A95: 193-201(1967). (COO-7-404).

The polarization of neutrons scattered elastically by elements from Ti to Bi was measured at lab scattering angles of 40, 60, and 90° for 4.4-MeV, at 60 and 90° for 5.0-MeV and at 40° for 5.5-MeV neutrons. The results were compared with optical-model calculations. The calculated polarizations agree reasonably well with the experimental values except for the 60° data at 4.4 MeV for elements with atomic weights greater than 120. At 40° where the polarizations are less than about 15%, the statistical uncertainties make it difficult to compare the data with the optical-model calculations. (auth)

13841 PRODUCTION RATIOS OF THE ^{38}K ISOMERS IN NUCLEAR REACTIONS. Bueget, N. (Univ. of Birmingham, Eng.); Chackett, K. F. Nucl. Phys., A95: 80-96(1967).

The production ratios of ^{38m}K and ^{38g}K were measured in the reaction ^{40}Ar(p,3n)^{38}K over the range E_p = 29 to 48 MeV and in the reaction ^{37}Cl(^{3}He,2n)^{38}K over the range E(^{3}He) = 10 to 23 MeV. The

results show a fair agreement with calculations assuming a compound-nucleus model with a nuclear moment of inertia about one-half the rigid-body value and a nuclear temperature varying with excitation energy. A prediction is made of the isomer ratio to be expected in high-energy (spallation) reactions. (auth)

13842 A ^{50}V(d,p) EXPERIMENT. De Lopez, M. E. (Univ. Nacional, Mexico); Mazari, M.; Belote, T. A.; Dorenbusch, W. E.; Hansen, Ole. Nucl. Phys., A94: 673-86(1967).

The reaction ^{50}V(d,p)^{51}V was investigated at 7.50-MeV bombarding energy, using a multi-angle spectrograph. A total of 71 transitions were recorded below 6.65 MeV of excitation in ^{51}V. l_n-values and spectroscopic strengths were determined from the measured proton angular distributions by a distorted-wave analysis. The spectroscopic strengths are analyzed in terms of the multipole sum rules for orders $\lambda = 0$, 1, and 2. It is concluded that the ^{50}V(g.s) wave function does not have good seniority. The possibility of observing "intermediate structure" in the (d,p) strength function is discussed. (auth)

13843 THE ^{28}Si NUCLEUS IN THE HARTREE–FOCK MODEL. Das Gupta, S. (McGill Univ., Montreal); Harvey, M. Nucl. Phys., A94: 602-16(1967).

An estimate of the energies of all the low-lying states of ^{28}Si was made using the Hartree–Fock and Tamm–Dancoff methods. A one-one correspondence with the correct ordering was obtained for all observed levels below 8 MeV; however, the calculated spectrum is too dense by about a factor of two. Possible reasons for this compression are discussed. Relative E2 transition rates are in fair agreement with experiment. Extensive comparisons are made with a parallel investigation using the SU_3 model, and the failure of the latter model in this case is discussed. An interpretation is made of some of the low-lying states in terms of the Bohr–Mottelson model of a rotating-vibrating nucleus. (auth)

13844 THE ABSOLUTE CROSS SECTIONS OF THE ^{39}K(n,p)^{39}Ar AND ^{39}K(n,α)^{36}Cl REACTIONS FOR 2.46-MeV NEUTRONS. Johnson, P. B.; Chapman, N. G.; Callaghan, J. E. (Victoria Univ. of Wellington, New Zealand). Nucl. Phys., A94: 617-24(1967).

Measurements of the absolute cross sections of the ^{39}K(n,p)^{39}Ar and ^{39}K(n,α)^{36}Cl reactions were made at a neutron energy of 2.46 ± 0.04 MeV in order to resolve the disagreement existing in previously published values. The neutron flux was determined using the associated particle coincidence technique in conjunction with the D(d,n)^{3}He reaction. The use of a silicon surface barrier detector with a thin nickel foil window enabled complete resolution of the ^{3}He peak with consequent improved neutron flux measurement. The results obtained, $\sigma(n,p) = 95 \pm 4$ mb and $\sigma(n,\alpha) = 6.2 \pm 1$ mb, are compared with previous measurements. (auth)

13845 ENERGY LEVELS OF ^{36}Ar FROM THE ^{37}Cl(p,α_0)^{34}S REACTION. Bosnjakovic, B.; Van Best, J. A.; Bouwmeester, J. (Univ., Utrecht). Nucl. Phys., A94: 625-52(1967).

The ^{37}Cl(p,α_0)^{34}S reaction was investigated in the energy region E_p = 850 to 2000 keV; 130 resonances were observed. Resonance strengths and energies are reported. Angular distributions of α_0 particles were measured at 77 resonances. The analysis allowed unique spin and parity assignments for 28 cases. In 32 cases two different spin assignments were possible. Formation and population parameters were determined. Formation of the 1$^-$ resonance at 1591.8 keV and the 2$^+$ resonance at 1860.6 keV proceeds purely through channel spin 1. The measured level density shows a good agreement with theoretical predictions. The isobaric analogues of the lowest two excited states of ^{36}Cl were observed although the α_0 decay is T-forbidden. The strength of the $J^\pi = 3^-$ analogue state, split in several components, is in excellent agreement with the corresponding (d,p) strength, measured by Rapaport and Buechner. (auth)

13846 THE 2.791- AND 2.87-MeV STATES IN ^{21}Ne. Pronko, J. G.; Rolfs, C.; Maier, H. J. (Univ., Freiburg i. B.). Nucl. Phys., A94: 561-79(1967).

The 2.87- and 2.791-MeV states in ^{21}Ne were studied using the reaction ^{18}O(α,nγ)^{21}Ne. A series of γ-γ and n-γ angular correlation measurements indicate that the 2.791- and 2.87-MeV states have spin J = $^3/_2$ and $^5/_2$, respectively. The 2.791-MeV state decays 85% to the $J^\pi = {}^1/_2{}^+$ first excited state with a quadrupole/dipole mixing ratio of +10.0 ± 5.0 and 15% to the $J^\pi = {}^3/_2{}^+$ ground state with a quadrupole/dipole mixing ratio of +0.45 ± 0.15 or +6.0 ± 3.0. The 2.87-MeV state decays 69% to the $J^\pi = {}^1/_2{}^+$ second excited state with a quadrupole/dipole mixing ratio of +0.06 ± 0.03 and 31% to the $J^\pi = {}^3/_2{}^+$ first excited state. A comparison of these results is made with ^{21}Na and ^{23}Na data. (auth)

13847 AN OPTICAL-MODEL ANALYSIS OF 18.6-MeV PROTON ELASTIC SCATTERING. Kossanyi-Demay, P.; de Swiniarski, R.; Glashausser, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A94: 513-27(1967).

The differential cross sections and polarizations for the elastic scattering of 18.6-MeV protons from the nuclei ^{48}Ti, ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{56}Fe, ^{58}Ni, ^{62}Ni, ^{63}Cu, and ^{64}Ni were analyzed in terms of the optical model. Other sets of polarization measurements at 16.5 MeV on ^{52}Cr, ^{60}Ni, and ^{62}Ni are also presented. Results cover the angular range 20 to 150°. A single set of geometrical parameters gives good fits to all experimental data. The radius of the spin-orbit potential is smaller by about 10% than that of the central potential. It is verified that the introduction of a volume absorption strength does not improve the fits. The symmetry or (N–Z)/A dependence may be ascribed either to the real well depth or to the imaginary part of the potential. (auth)

13848 THE ^{28}Si NUCLEUS IN THE SU_3 MODEL. Bernier, J.-P.; Harvey, M. (Chalk River Nuclear Labs., Ont.). Nucl. Phys., A94: 593-601(1967).

A study of the ^{28}Si nucleus is made within the framework of the SU_3 model. The crucial experimental data invalidating the pure SU_3 scheme are emphasized, and possible reasons for this failure are discussed. The structure of SU_3 states is analyzed to prepare for a better understanding of the Hartree-Fock states in an accompanying paper. (auth)

13849 NON-ELASTIC INTERACTION CROSS SECTIONS OF NEUTRONS WITH ^{7}Li, ^{12}C, ^{14}N, ^{27}Al, ^{56}Fe, Cu, Pb, ^{235}U, ^{238}U, AND ^{239}Pu. Degtyarev, Yu. G. J. Nucl. Energy: Pt. A and B, 20: 818-19(Sept. 1966).

Inelastic scattering cross sections for neutrons of energy 8.1 and 13 to 21 MeV were measured for ^{7}Li, ^{12}C, ^{14}N, ^{27}Al, ^{56}Fe, Cu, Pb, ^{235}U, ^{238}U, and ^{239}Pu using a neutron transmission technique with spherical samples. A detector which was insensitive to inelastically scattered neutrons was used to measure the flux of neutrons from an external monoenergetic source, first with the source inside the spherical sample, and then with the sample removed. The elastically scattered neutrons are automatically compensated for in this method. The transmission coefficients so obtained are a measure of the inelastic scattering cross sections. (S.F.L.)

13850 MEASUREMENTS OF 14 MeV NEUTRON INDUCED REACTION CROSS SECTIONS USING ENRICHED ISOTOPES OF CALCIUM. Tiwari, P. N.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/12, 6p. (CONF-661014–40). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Cross sections for the reactions ^{27}Al(n,p)^{27}Mg, ^{40}Ca(n,t)^{38g}K, ^{42}Ca(n,p)^{42}K, ^{43}Ca(n,p)^{43}K, ^{43}Ca(n,d)^{42}K, ^{44}Ca(n,p)^{44}K, ^{44}Ca(n,α)^{41}Ar, ^{44}Ca(n,d)^{43}K, ^{48}Ca(n,2n)^{47}Ca, ^{39}K(n,2n)^{38g}K, ^{41}K(n,p)^{41}Ar, and ^{41}K(n,α)^{38}Cl at 14 Mev were measured. The results were compared with other experimental values. (D.C.W.)

13851 STUDY OF THE ^{32,34}S(n,d)^{31,33}P REACTIONS AT 14.1 MeV. Wagner, R. 13p. (CONF-660411–62). DTIE. Gmelin, AED-CONF-66-060-147.

From American Physical Society Meeting, Washington, D. C.

Angular distributions and spectra for the reactions ^{32}S(n,d)^{31}P and ^{34}S(n,d)^{33}P at 14.1 MeV were measured. Attempts were made to fit the angular distributions using the Butler theory and the DWBA approximation. (D.C.W.)

13852 STUDY OF ^{20}Ne LEVELS BY RADIATIVE CAPTURE. Ollerhead, R. W.; Alexander, T. K.; Broude, C.; Ferguson, A. J.; Kuehner, J. A.; Litherland, A. E.; Smulders, P. J. M. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). 20p. (CONF-660639–5). DTIE. Gmelin, AED-CONF-66-221-7.

From Congress-Canadian Association of Physicists, Sherbrooke, Quebec.

The energy levels of ^{20}Ne were investigated by measuring gamma spectra and yields from the reactions ^{4}He(O-16,γ) and ^{16}O(α,γ). Radiative widths and F2 enhancements for gamma transitions were determined. (D.C.W.)

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Refer also to abstracts 13783, 13796, 13823, 13849, 13917, and 13933.

13853 (AE–263) POSSIBLE DEFORMED STATES IN ^{115}In AND ^{117}In. Baecklin, A.; Fogelberg, B.; Malmskog, S. G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1967. 40p. Dep. mn.

Levels and transitions in ^{115}In and ^{117}In were studied from the beta decay of 2.3-day ^{115g}Cd and 2.5-hr ^{117g}Cd. Using a Ge(Li) detector and a double-focusing beta spectrometer, energies,

intensities, conversion coefficients, and multipolarities were obtained for the following transitions (energies in keV and multipolarities are given): ^{115}In: 35.63 (97.0% M1 + 3.0% E2), 231.47 (E1), 260.80 (M1), 267, 336.23 (M4 + < 5% E5), 492.14 (96% E1+ 4% M2), 527.70 (E1). ^{117}In: 71.0, 89.80 (E2 + < 20% M1). 273.32 (M1, E2), 315.27 (M4 + < 7% E2), 344.29 (E1), 434.12 (E1). Using the delayed coincidence technique, half lives were measured for 2 levels in ^{115}In and for 3 levels in ^{117}In. Energies, spins, parities, and half lives are given for the following levels: ^{115}In: 597.03, $\frac{3}{2}^-$; 828.39, $\frac{3}{2}^+$, 5.4 nsec; 863.95, $\frac{1}{2}^+$ or $\frac{3}{2}^+$, 1.1 nsec; ^{117}In: 588.59, $\frac{3}{2}^-$; 0.20 nsec; 659.56, $\frac{3}{2}^+$, 58.7 nsec; 749.37, $\frac{1}{2}^+$ or $\frac{3}{2}^+$, 4.3 nsec. Reduced transition probabilities are given for several transitions in both nuclei. The E2 transition rates between the two excited positive parity states in both nuclei were found to be about 100 s. p. u. indicating a possible deformation of these states. The energy spacing and transition rates between these states can be well accounted for within the Nilsson model assuming the states to form a K = ($\frac{1}{2}^+$) rotational band. A deformation δ of about 0.20 is obtained for both nuclei. (auth)

13854 (AE-264) DECAY OF THE 16.3-MIN ^{182}Ta ISOMER. Hoejeberg, M.; Malmskog, S. G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1967. 14p. Dep. mn.

Some transitions in the decay of the 16.3-min ^{182}Ta isomer were studied with a Ge(Li) detector and a double-lens electron-coincidence spectrometer. Gamma and conversion-electron intensities were measured. From a delayed coincidence experiment, it was concluded that both of the two lowest excited states in ^{182}Ta had a half life less than 30 psec. (auth)

13855 (AE-265) DECAY PROPERTIES OF ^{147}Nd. Baecklin, A.; Malmskog, S. G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1967. 16p. Dep. mn.

Electron and gamma transition energies and intensities in the decay of ^{147}Nd were studied using a double-focusing beta spectrometer and a Ge(Li) detector. From the deduced multi-polarities of the transitions, all levels in ^{147}Pm are found to have positive parity in contrast to the fact that the neighboring nucleus ^{149}Pm has been found to have several low-lying negative-parity states. (auth)

13856 (JINR-E4-3051) NON-ROTATIONAL STATES OF ODD-MASS DEFORMED NUCLEI IN THE REGION 155 ≤ A ≤ 181. Soloviev, V. G.; Vogel, P.; Jungklaussen, G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 24p. Dep. mn.

The results of some calculations of the energies and the wave functions of states of some odd-A, 155 ≤ A ≤ 181 nuclei are presented. In some cases decoupling parameters and spectroscopic factors are also given. (D.C.W.)

13857 (JINR-P6-2986) ISSLEDOVANIE γ-SPEKTROV ^{75}Se, ^{106}Rh, ^{110m}Ag, ^{124}Sb, ^{125}Sb, ^{140}Ba, ^{140}La I ^{154}Eu. (Investigation of γ-Spectra of ^{75}Se, ^{106}Rh, ^{110m}Ag, ^{124}Sb, ^{125}Sb, ^{140}Ba, ^{140}La, and ^{154}Eu). (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 73p. (In Russian). Dep. mn.

Gamma spectra of ^{75}Se, ^{106}Rh, ^{110m}Ag, ^{124}Sb, ^{125}Sb, ^{140}Ba, ^{140}La, and ^{154}Eu were investigated by using a Ge(Li) spectrometer with a volume of 5 cm^3 and drift thickness of 6 mm. Relative intensities and the multipolarities of γ transitions observed were determined. These data allowed in some cases specification of the decay mode and log ft values for different levels. (auth)

13858 (YALE-2726-H-88) NEW ISOTOPE STUDIES USING HEAVY-ION INDUCED REACTIONS. Preiss, I. L.; Bakhru, H.; D'Auria, J. M.; Li, A. C. (Yale Univ., New Haven, Conn.). Aug. 1966. Contract AT(30-1)-2726. 26p. (CONF-660817-9). DTIE.

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden.

Radiochemical and nuclear spectroscopic techniques used to study the ground states or isomeric states of nuclei formed in heavy-ion induced reactions are discussed. Because the radiochemical or mass-spectrometric separations may take so long (with respect to the half-lives involved) so as to preclude detailed studies that are generally desirable in classical nuclear spectroscopy, the approach has been to perform as many standard measurements as possible on a given isotope, and then to compare its decay scheme with those of its neighbors, so as to establish the trends in a given mass region, rather than attempting to deduce nuclear structure properties from a single more detailed study of one isotope or member of an isobaric chain. (S.F.L.)

13859 (UCRL-Trans-1336) NEW DATA ON THE ALPHA DECAY OF ^{233}U. Baranov, S. A.; Gadzhiev, M. K.; Kulakov, V. M.; Shatinskii, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by M. Kassatkin (Univ. of California Lawrence Radiation Lab., Berkeley), from report IAE-1081. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $4.60 fs, $1.46 mf.

The α spectrum of ^{233}U was studied in detail with a large magnetic α spectrograph. Thirty-one α groups were found, 19 of which were discovered for the first time. On the basis of experimental data, a scheme of the energy levels of the ^{229}Th nucleus was plotted. The analysis of the data made it possible to assume that there exist at least six rotational bands in ^{229}Th with quantum characteristics of $\frac{5}{2}^+$ [633], $\frac{1}{2}^-$ [743], $\frac{5}{2}^-$ [752], $\frac{1}{2}^+$ [?], and apparently $\frac{3}{2}^+$ [631] and $\frac{5}{2}^+$ [622]. (auth)

13860 SOME CHARACTERISTICS OF SPONTANEOUS FISSION OF HEAVY NUCLEI. Dmitrieva, I. K. (Inst. of Nuclear Power, Academy of Sciences, Belorussian SSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 119-22(1966). (In Russian).

An attempt was made at correlating the changes in the nuclear thresholds and half lives with the additional value of surface tension, depending on the structure of the nuclei. The curves for the K(N,Z) relations were constructed on the basis of nuclear spontaneous fission magnitudes. The data obtained were in good agreement with the experimental data. Numerical magnitudes for the spontaneous fission thresholds are tabulated for Am, Bk, Cf, Es, Fm, Pu, Th, and U isotopes, and curves of spontaneous fission periods for Cm, Cf, Fm, and 102 and 104 isotopes are included. (R.V.J.)

13861 MEASUREMENT OF THE NUCLEAR MOMENT OF ^{187}Os USING A PULSE-TECHNIQUE FOR THE DETECTION OF VERY WEAK NMR-SIGNALS. Kaufmann, J.; Schwenk, A. (Univ., Tuebingen, Ger.). Phys. Lett., 24A: 115-16(Jan. 16, 1967).

A pulse-technique is described to detect very weak NMR signals and, particularly, to search for an unknown, narrow NMR line lying in a wide frequency range in short measuring time and without paramagnetic additions. The nuclear magnetic moment of ^{187}Os was measured. (auth)

13862 HYPERFINE-STRUCTURE MEASUREMENTS ON ^{161}Dy AND ^{163}Dy. Ebenhoeh, W.; Ehlers, V. J.; Ferch, J. (Univ., Heidelberg). Z. Phys., 200: 84-92(1967).

An atomic beam magnetic resonance experiment was used to determine the hyperfine interaction constants A and B of the $^5I_8$ ground state of ^{161}Dy and ^{163}Dy. Using an effective value for $\langle r^{-3} \rangle$, the magnetic moments and electric quadrupole moments of the ^{161}Dy and ^{163}Dy nuclei were calculated. (auth)

13863 SPIN-SPIN INTERACTION OF 0.92-MeV POLARIZED NEUTRONS WITH POLARIZED ^{165}Ho NUCLEI. Kobayashi, Shinsaku; Kamitsubo, Hiromichi; Katori, Kenji; Uchida, Akira; Imaizumi, Minoru; Nagamine, Kanetada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1071-3(Nov. 1966). (NP-16537).

A direct observation of the spin-spin interaction in a nuclear reaction was made by measuring the transmitted intensity of (0.92 ± 0.01)-MeV polarized neutrons through polarized ^{165}Ho. A high degree of nuclear polarization of the ^{165}Ho target (f_1 = 0.31 ± 0.03) was attained by using a polycrystalline metallic sample in cylindrical form (3.4 cm dia. and 1.7 cm thickness) at a temperature of 1.12 ± 0.04°K in an external magnetic field of 23 kOe. Experiments were made with both parallel and antiparallel orientations of the neutron and nuclear spins. A statistical treatment of the data gave a change in the total cross section (from parallel to antiparallel orientations of spin) as $\Delta\sigma = -(128 \pm 66)$ mb. The minus sign results from a larger cross section for the antiparallel orientation. From this value of $\Delta\sigma$, the magnitude of the strength α for the spin-spin interaction was estimated to be α = +5.8 ± 3.0 MeV using a radial form factor f(r) taken in the same form as the real part of a central potential. A calculation performed for the f(r) of a Gaussian surface interaction taken in the same form as the imaginary part of the central potential gave α = +1.09 ± 0.56 MeV. (S.F.L.)

13864 SOME PECULIARITIES OF THE GAMMA-RAY SPECTRA OF THE NEUTRON-ACTIVATED Te AND CdTe CRYSTALS AND THE ACTIVATION CROSS-SECTIONS OF Te ISOTOPES. Makaryunene, E. K.; Makaryunas, K. V. (Department of the Nuclear Physics and Application of Radioactive Isotopes, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 317-22(1966). (In Russian).

The gamma-ray spectra of Te and CdTe crystals activated by reactor-spectrum neutrons were measured with a NaI(Tl) scintillation spectrometer. Some differences in the relative intensities of the gamma rays of various Te isotopes in the Te and CdTe sources were found. This fact shows that dependences of the activation cross sections versus neutron energy in the various Te isotopes are different. The deviation from 1/v low for some Te isotopes must exist. The neutron activation cross sections for some Te isotopes in a reactor were determined. (auth)

13865 FOUR-QUASIPARTICLE EXCITATIONS AND TWO-PHONON VIBRATIONAL STATES IN SPHERICAL NUCLEI:

EVEN-PARITY STATES OF EVEN TIN ISOTOPES. Ottaviani, P. L. (Univ., Bologna); Savoia, M.; Sawicki, J.; Tomasini, A. Phys. Rev., 153: 1138-47(Jan. 20, 1967).

A microscopic theory of the low-lying states of even-even spherical nuclei is developed in which eigenvectors are linear combinations of two- and four-quasiparticle excitations. The quasiparticles are defined by the Bogoliubov-Valatin canonical transformation. The method is called the quasiparticle second Tamm-Dancoff (QSTD) approximation, since no ground-state correlations are included. It is found that the spurious kets due to the particle-number nonconservation must be absolutely projected out of the secular matrices before their diagonalization. Such a procedure is described and applied. Formulas are given for the electromagnetic transition probabilities. The theory is applied to the study of the 2^+, 4^+, and 0^+ states of the even tin isotopes. The single-particle radial wave functions employed are those of a Saxon-Woods potential and of a harmonic-oscillator potential. The two-nucleon residual interaction potential is spin-dependent and of zero range. Satisfactory numerical agreement with the observed 2^+ and 4^+ low-lying levels is obtained with the Saxon-Woods wave functions for a reasonable strength constant of our zero-range force. Appreciable admixtures of the four-quasiparticle creation components are found even in the lowest-lying levels. Poor agreement is obtained for the 0^+ states, for which a more refined theory is necessary (rather unreasonable values of the strength constant of the zero-range potential are required to fit the 0^+ data). Generally, markedly worse 2^+ results are obtained if the Saxon-Woods wave functions are replaced with harmonic-oscillator wave functions. (auth)

13866 RADIATIVE CAPTURE AND NEUTRON EMISSION IN $^{139}La + \alpha$ AND $^{142}Ce + p$. Verdieck, E. V.; Miller, J. M. (Columbia Univ., New York). Phys. Rev., 153: 1253-61(Jan. 20, 1967).

The excitation functions for the reactions $^{139}La(\alpha,\gamma)^{143}Pr$, $^{142}Ce(p,\gamma)^{143}Pr$, $^{139}La(\alpha,n)^{142}Pr$, and $^{142}Ce(p,n)^{142}Pr$ at excitation energies of 8 to 38 MeV were measured. The excitation function of the (α,γ) reaction rises to about 75 μb at 17-MeV excitation energy and falls to about 10 μb at 28-MeV excitation energy. The excitation function of the (p,γ) reaction rises to about 650 μb at 19-MeV and falls to about 80 μb at 36-MeV excitation energy. The large difference both in the shapes and in the magnitudes at the maxima of the two excitation functions, despite the fact that both reactions proceed through the same compound system ^{143}Pr, is evidence for a direct contribution to the radiative capture of protons. A calculation of the (α,γ) excitation function based upon the compound-nucleus model agrees reasonably well with the experimental results, while a direct-interaction calculation of the (p,γ) reaction, although not in good agreement with the experimental results, gives a substantially better agreement than one within the compound-nucleus formalism. The (α,n) and (p,n) excitation functions both rise to a maximum of about 130 mb at 15 MeV and fall to around 10 mb at 38 MeV. The calculated cross sections according to the compound-nucleus mechanism are in reasonable agreement with the experimental results except at the high-energy end—where, nevertheless, both the shapes and the magnitudes of the two excitation functions are the same. (auth)

13867 NEUTRON TOTAL CROSS SECTION OF ^{204}Pb FOR $5 < E_n < 80$ keV AND OF ^{208}Pb FOR $25 < E_n < 84$ keV. Gibbons, J. H.; Macklin, R. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 153: 1356-8(Jan. 20, 1967). (ORNL-P-2542).

The neutron total cross section of ^{204}Pb was studied for neutron energies from 5 to 80 keV, using fast time-of-flight techniques. At least 10 s-wave resonances were observed in this interval in addition to a number of probable p-wave resonances. The average observed s-wave level spacing is 2.7 ± 0.5 keV, and the s-wave strength function is $0.55 \pm 0.2 \times 10^{-4}$. The total cross section of ^{208}Pb was measured from 26 to 84 keV. Resonances were observed at about 70 and 77 keV, both apparently due to $l = 1$ neutrons. The effective nuclear radius R' for $^{208}Pb + n$ was found to be 8.4 ± 0.3 F. (auth)

13868 QUASIPARTICLE MODEL FOR ^{140}La. Struble, Gordon L. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 153: 1347-55(Jan. 20, 1967). (UCRL-16692).

A model is proposed for odd-odd nuclei in which the independent excitations are quasiparticles defined by a special Bogoliubov transformation and in which a finite-range two-body central force acts as the residual interaction. The model is applied to ^{140}La, whose energy levels, wave functions, (d,p) spectroscopic factors, and M1 transition rates are computed and are compared with experimental values. (auth)

13869 STUDY OF THE LEVELS IN ^{140}La BY (d,p) STRIPPING REACTION. Kern, Jean; Struble, Gordon L.; Sheline, Raymond K. (Florida State Univ., Tallahassee. Univ. of California, Berkeley). Contract W-7405-eng-48; AT(40-1)-2434. Phys. Rev., 153: 1331-46(Jan. 20, 1967). (UCRL-16598).

The energy levels in ^{140}La were studied by means of (d,p) reaction spectroscopy using 10-MeV deuterons. The protons that emerged were analyzed by a single-gap, broad-range magnetic spectrograph with 13-keV resolution. A reaction Q-value of 2938 ± 3 keV was obtained. Exposures were taken at eight angles ranging from 25 to 105°. All spectra were fitted, using a least-square code, up to an excitation energy of 1860 keV. Seventy states were observed, and the angular distributions of the most prominent groups were analyzed by means of distorted-wave Born-approximation stripping theory. Spins of the ^{140}La levels determined from previous decay-scheme studies and the present research, and the proton intensities observed in the $^{139}La(d,p)^{140}La$ reaction, can be satisfactorily explained in terms of the mixed configurations, $(1g_{\frac{9}{2}})_p(2f_{\frac{5}{2}})_n$ and $(2d_{\frac{5}{2}})_p(2f_{\frac{5}{2}})_n$. Above 600 keV, however, interpretation of states in terms of higher energy configurations appears also to require phonon-particle coupling. (auth)

13870 DECAY OF ^{129}Cs AND ^{131}I TO THE LEVELS IN ^{129}Xe AND ^{131}Xe. Graeffe, G.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Phys. Rev., 153: 1321-30(Jan. 20, 1967). (MIT-905-70).

The decay schemes of ^{129}Cs and ^{131}I were investigated using Ge(Li) and Si(Li) semiconductor detectors as well as various coincidence techniques. Gamma energies and relative gamma intensities were determined as well as conversion coefficients for many transitions. In ^{129}Xe, levels at 322.0 and 904.9 keV were proposed, which have not been reported earlier. The spin and parity assignments for the 322.0-keV level are probably $\frac{5}{2}+$. In ^{131}Xe, a level at 404.8 keV was found which was not previously known. The spin and parity assignments for this level are $\frac{1}{2}+$ or $\frac{3}{2}+$. Beta-gamma coincidence measurements were used to indicate that the 503-keV γ ray in ^{131}I decay feeds the $11\frac{1}{2}-$ isomer of ^{131}Xe. Decay schemes for both ^{129}Cs and ^{131}I consistent with the observations were constructed. The levels of ^{129}Xe and ^{131}Xe are compared with each other and with current theoretical calculations. (auth)

13871 DECAY OF ^{145}Eu. Hill, John C. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1312-20(Jan. 20, 1967).

The decay scheme of ^{145}Eu was studied by the techniques of beta and gamma spectroscopy. The half life was measured to be 5.93 ± 0.1 days. Thirty-three gamma transitions were identified by means of NaI and germanium gamma detectors and 180° magnetic spectrometers. Gamma-gamma coincidences were performed using both NaI and germanium detectors. Most of the transitions were incorporated into the decay scheme in a consistent manner. The multipolarity of several gamma transitions was determined from measurement of conversion coefficients, and a positron spectrum containing two branches was observed. The level scheme of ^{145}Sm contains a first excited state at 0.895 MeV and a second excited state at 1.437 MeV. Above 1.5 MeV, the level density greatly increases. Levels with both even and odd parities were observed, and the energy between the ground states of ^{145}Eu and ^{145}Sm was determined to be about 2.75 MeV. Systematics for the first excited states of nuclei with even proton number and a neutron number near 82 are presented. (auth)

13872 DECAY OF 10.4-min ^{162}Gd. Wahlgren, M. A.; Stewart, D. C.; Lawless, F. R.; Hines, J. J.; Flynn, K. F.; Lerner, J. L. (Argonne National Lab., Ill.). Phys. Rev., 153: 1310-11 (Jan. 20, 1967).

A short-lived ^{162}Gd isotope was produced by double neutron capture during the Savannah River high-flux reactor experiment. The new isotope decays with a half life of 10.4 ± 0.2 min to the 7.4-min isomer of ^{162}Tb. Gamma rays of 410 and 428 keV were observed in the decay of 10.4-min ^{162}Gd. (auth)

13873 MIXING OF THE GROUND-STATE AND GAMMA-VIBRATIONAL BANDS IN ^{166}Er AND ^{168}Er. Gunther, Christian; Parsignault, Daniel R. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev., 153: 1297-1310(Jan. 20, 1967). (CALT-63-37).

Gamma intensities were measured in ^{166}Er and ^{168}Er with an accuracy of a few percent, using a Ge(Li) detector. Several new γ transitions, not previously reported, were observed. The half life of the 1095-keV state in ^{168}Er was measured to be 115.7 ± 3.3 nsec. The E2 branching ratios from the gamma band to the ground-state band are in excellent agreement with the band-mixing theory. The z_2 values obtained are 0.0460 ± 0.0010 for ^{166}Er and 0.0388 ± 0.0015 for ^{168}Er. These z_2 parameters as well as some recent values for other even-even nuclei in the $150 < A < 190$ regions are compared with values calculated according to different theories. The theories and the experiments give the same mass dependence of z_2. However, the experimental values are up to a factor of 2 higher than the theoretical values. The ratios of the

intrinsic E2 matrix elements, $\langle 2|M'(E2,0)|2\rangle/\langle 0|M'(E2,-2)|2\rangle$ are derived as 9.8 ± 0.3 for ^{168}Er and 9.2 ± 0.7 for ^{166}Er. Using Coulomb-excitation data, for the ratio of the quadrupole moments, $Q_0(K=2)/Q_0(K=0)$, the values 1.38 ± 0.15 for ^{166}Er and 1.15 ± 0.14 for ^{168}Er are obtained. Finally, the γ transition rates from the negative-parity states are discussed in terms of the collective nuclear model. (auth)

13874 STUDY OF THE (p,t) REACTION ON THE Pb ISOTOPES. Reynolds, G. M.; Maxwell, J. R.; Hintz, Norton M. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1265. Phys. Rev., 153: 1283-7(Jan. 20, 1967). (COO-1265-37).

Energy spectra of tritons from the (p,t) reaction on ^{208}Pb, ^{207}Pb, ^{206}Pb, and ^{204}Pb were studied using 40-MeV protons. Angular distributions of the resolvable triton groups are presented. A detailed discussion of the ^{208}Pb results is given in terms of the two-nucleon transfer theory of Glendenning and the wave functions of True and Ford for the ^{206}Pb states. (auth)

13875 DECAY OF ^{137}Pr. Van Hise, J. R.; Ketelle, B. H.; Brosi, A. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 153: 1287-93(Jan. 20, 1967). (ORNL-P-2512).

A praseodymium isotope with a half life of 75 min was assigned to ^{137}Pr. It decays with a K-capture-to-positron ratio of 2.5 ± 0.2 and a maximum positron energy of 1.74 ± 0.05 MeV. Approximately 6% of the disintegrations are to excited states of ^{137}Ce. The energies and intensities of 28 gamma transitions were measured with a Ge(Li) detector. Coincidences of the gamma rays were measured using two 3-in. NaI(Tl) crystals and a multiparameter analyzer. An energy-level diagram consistent with the observed gamma energies, intensities, and coincidences was deduced. (auth)

13876 FISSION OF RHENIUM BY INTERMEDIATE-ENERGY HELIUM IONS. Menninga, Clarence; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1294-6(Jan. 20, 1967).

Cross sections were determined radiochemically for twelve nuclides resulting from fission which was induced by the 40.9-MeV ^{4}He ion bombardment of naturally occurring ^{185}Re and ^{187}Re. The mass distribution was observed to be symmetric, with a full width at half maximum of 23 ± 2 mass units. The average number of prompt neutrons emitted per fission event was 1 ± 1, and the total fission cross section was found to be 2.4 ± 0.6 μb. These results are compared with those from fission of other nuclei. (auth)

13877 DECAY OF ^{162}Tb AND THE EXCITED STATES OF ^{162}Dy. Gujrathi, S. C.; Bakhru, H.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 153: 1262-9(Jan. 20, 1967).

Sources of 7.5-min ^{162}Tb were produced by the ^{162}Dy(n,p)^{162}Tb and ^{165}Ho(n,α)^{162}Tb reactions with 14.8-MeV neutrons. The decay properties of ^{162}Tb were investigated with the help of standard scintillation-counter techniques. In the beta and gamma measurements, the beta groups with end-point energies of 1.72 ± 0.1 MeV (13%) and 1.45 ± 0.1 MeV (87%), and the gamma rays with energies of 45 ± 5, 80 ± 5, 130 ± 5, 185 ± 10, 195 ± 10, 265 ± 5, 390 ± 10, 630 ± 10, 690 ± 15, 810 ± 10, 880 ± 10, 890 ± 10, 1070 ± 15, and 1205 ± 15 keV, all decaying with a half life of 7.5 min, were observed. The sum-spectrum and coincidence studies show that the following are gamma cascades: 130–265–810–80; 130–265–890; 130–265–625–185–89; 130–195–880–80; 130–195–690–185–80; 130–1070–80; 395–810–80; 395–890; and 1205–80 keV. The beta-gamma coincidences taking each of the 80-, 810-, and 890-keV gamma rays as a gate show both of the above beta groups; while in those taking the 190- and 265-keV gamma rays as a gate, only a single beta group with the end-point energy of 1.45 ± 0.1 MeV was observed. Based on these results, a decay scheme for ^{162}Tb is proposed with levels in ^{162}Dy at 890 (2^+,k = 2), 924 (8^+,k = 0), 960 (3^+,k = 2), and 1155 keV (2^-,k = 2) and is discussed in terms of the unified model. (auth)

13878 EXCITATION FUNCTIONS FOR THE HELIUM-ION-INDUCED FISSION OF RHENIUM, LUTETIUM, AND THULIUM. Raisbeck, Grant M.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1270-82(Jan. 20, 1967). (COO-347-26).

The helium-ion-induced fission excitation functions of rhenium, lutetium, and thulium were measured in the energy interval of 30 to 80 MeV using a "fission-track" technique with plastic films as detectors. By analyzing the ratio Γ_f/Γ_n, which measures competition between fission and neutron emission, fission thresholds of 22.4, 23.6, 27.5, and 28.7 MeV were determined for ^{189}Ir, ^{191}Ir, ^{179}Ta and ^{173}Lu, respectively. These values are obtained using a level-density parameter $a_f = A/10$, with the uncertainty of this choice introducing a possible error of ±2.5 MeV in the calculated barriers. The thresholds, which are of particular interest because the nuclides involved are removed from the closed-shell region are in agreement with predictions of a recently proposed semi-empirical mass formulation based on a charged liquid drop. Correlations are given showing the relationship of Γ_f/Γ_n with Z^2/A and $E_f' - B_n'$, where E_f' and B_n' are the effective fission barrier and the neutron binding energy. The results suggest that shell effects tend to persist even at excitation energies of 30 MeV. Comparisons of the correlations with heavy-element data point out the marked discontinuity near Z = 90, and support the general two-mode fission hypothesis. (auth)

13879 A SPIN 11/2 ISOMER IN ^{157}Gd. Borggreen, J.; Westgaard, L.; Hansen, N. J. Sigurd (Univ. of Copenhagen). Nucl. Phys., A95: 202-8(1967).

Through the reaction ^{154}Sm(α,n), a 17 μsec half-life isomer at 425 keV in ^{157}Gd was investigated by a pulsed-beam technique. For several reasons, the isomeric level is believed to be the $^{11}/_2^-$ [505] Nilsson state. The decay is studied by using a Ge detector and by prompt as well as delayed coincidence techniques. The decay proceeds through two rotational bands, viz., the ground-state band and a band built on the $^5/_2^+$[642] Nilsson state, itself forming an isomeric level at 64 keV and with a half life of 0.46 μs. Comparison of stripping and pick-up reaction data with theory shows that the $^{11}/_2^-$ [505] Nilsson state is a hole state. By bombardment of ^{152}Sm and ^{150}Sm with α particles, isomeric decays were observed; the half lives being 31 msec and 84 μsec, respectively. (auth)

13880 SPIN-FLIP GIANT RESONANCE AND PARTICLE-HOLE STRUCTURE IN ^{90}Zr. Drechsel, D.; Seaborn, J. B.; Greiner, W. (Univ., Frankfurt am Main). Nucl. Phys., A94: 698-704(1967).

Particle-hole calculations in ^{90}Zr are performed using three different single-particle spectra. The 1^- eigenstates are classified according to the distribution of dipole and spin-dipole strength. The gross structure is independent of details of the single-particle spectrum and is insensitive to reasonable variations of the nucleon-nucleon force. In addition to the strong giant dipole resonance, the calculation also gives a group of levels on either side of the main peak separated from it by about 4 MeV. These levels carry spin-dipole strength and could be identified with the collective spin-flip giant resonance. The dipole states occurring in the 12-MeV region seem to be closely connected with the structure observed at this energy in recent (p,γ) experiments by Rössle and his group. Whereas in photo-excitation one observes only the states with dipole strength, it is possible to study the spin-flip giant resonances by means of inelastic electron scattering at higher momentum transfer. (auth)

13881 CORRELATED MASS AND ENERGY DISTRIBUTIONS OF FISSION FRAGMENTS FROM ^{235}U BY SIMULTANEOUS VELOCITY AND ENERGY MEASUREMENTS. Andritsopoulos, G. (Reading Univ., Berks, Eng.). Nucl. Phys., A94: 537-49(1967).

A simultaneous determination of the mass and energy distributions both before (initial) and after (final) neutron emission of the fragments from thermal-neutron-induced fission of ^{235}U was made. The method which is developed involves the measurement of the correlated energies and velocities of the fission fragments from ^{235}U, by using a time-of-flight technique with solid state barrier layer detectors for the fragment detection. Fine structure in the initial mass yields, as well as in the final ones, is observed, with a characteristic periodicity of about 5 amu in both cases. The peaks in the structure of the final mass distribution are shifted by one to two mass units with respect to the peaks, which appear in the structure of the initial mass distribution. With about 2% experimental mass uncertainty, no additional structure is observed due to the dependence of the neutron emission on the mass. (auth)

13882 THE γ RADIATION OF ^{132}I. Ardisson, Gerard; Petit, Francois-Xavier (Univ., Nice). Compt. Rend., Ser. C, 263: 1408-11(Dec. 7, 1966). (In French).

The γ radiation of ^{132}I was studied after radiochemical separation with a spectrometer using a Ge n-i-p diode as detector. Several previously unreported γ rays were observed, and their energy and relative intensity were measured. (tr-auth)

13883 AN EXPERIMENTAL STUDY OF THE TIME DEPENDENCE OF THE BETA ENERGY SPECTRUM FROM ^{235}U FISSION FRAGMENTS. Kutcher, J. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 26: 435-46(Dec. 1966).

An absolute experimental measurement was made of the time dependence of the beta energy spectrum from fission fragments, specifically beta particles of energies greater than 0.75 MeV produced in the thermal neutron fission of ^{235}U. This measurement was made for four cases: the initiation of a constant fission rate in a cold uranium foil; shutdown after 1- and 3-hr runs at a steady fission rate; and an instantaneous burst of fissions produced by a reactor pulse. The fission source was a foil coated with approximately 38 mg of ^{235}U and placed in a thermal neutron beam from

a reactor. The fission rate was measured with an ionization chamber. The beta energy spectrum was measured with a plastic scintillator, with absolute counting being determined by the known solid angle between source and detector. Background counts were reduced to less than 10% in all cases. The total uncertainty in the analyzed data was less than 5% for the steady power runs and less than 8% for the reactor pulsing runs. The experimental results are in substantial agreement with those predicted by theory. (auth)

13884 MEASUREMENTS OF EFFECTIVE (SELF-SHIELDED) NEUTRON CROSS SECTIONS BY A FAST PULSED METHOD. Arai, E.; Miessner, H.; Beckurts, K. H. (Kernforschungszentrum, Karlsruhe, Ger. Institut fuer Angewandte Kernphysik, Karlsruhe, Ger.). Nucl. Sci. Eng., 26: 573-5(Dec. 1966).

Effective capture and transport cross sections were measured for Pb and ^{238}U at neutron energies of 7.5 and 30 keV using the fast pulsed method. (D.C.W.)

13885 PRODUCTION OF ^{185m}W IN A NUCLEAR REACTOR. Kramer, Henry H.; Wahl, Werner H. (Union Carbide Corp., Tuxedo, N. Y.). Nucl. Sci. Eng., 26: 575-7(Dec. 1966).

Samples enriched in ^{184}W were irradiated in a reactor to produce ^{185m}W by the ^{184}W(n,γ)^{185m}W reaction. The reactor-neutron cross section for this reaction was determined to be between 1.0 and 2.5 mb. The energies of the x-ray and gamma transitions of ^{185m}W were determined to be 60 ± 2, 131 ± 2, and 175 ± 2 keV. (D.C.W.)

13886 NEUTRON CAPTURE CROSS SECTION OF THE TUNGSTEN ISOTOPES FROM 0.01 TO 10 ELECTRON VOLTS. Friesenhahn, S. J.; Haddad, E.; Froehner, F. H.; Lopez, W. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 26: 487-99(Dec. 1966). (GA-6882).

Neutron capture cross-section measurements from 0.01 to 10 eV on ^{182}W, ^{183}W, ^{184}W, and ^{186}W employing a totally absorbing gamma detector are described. The shapes and magnitudes of the cross-section curves are compared to calculations using reported resonance parameters. Negative energy levels are postulated to account for the discrepancies between calculation and experiment for ^{182}W and ^{184}W. The ^{182}W parameters are: $E_0 = -30.7$ eV, $\Gamma_\gamma = 57$ MeV, $\Gamma_n^0 = 20$ MeV, g = 1, and for ^{184}W: $E_0 = -110$ eV, $\Gamma_\gamma = 57$ MeV, $\Gamma_n^0 = 48.4$ MeV, g = 1. The ^{183}W and ^{186}W measured cross sections are lower than those calculated from reported positive-energy resonance parameters. A measurement of the gold-capture cross section was used as a check on the experimental techniques employed. (auth)

13887 ENERGY LEVELS IN ^{145}Sm FROM THE DECAY OF ^{145}Eu. Draper, J. E.; Mead, R. O.; Warner, R. A. (Univ. of California, Davis). Nucl. Phys., A95: 209-21(1967).

A total of 24 gamma rays following the decay of ^{145}Eu were observed with a Ge(Li) detector; 17 of them correspond to ground state transitions in ^{145}Sm, which gives the level energies to a much greater precision than was possible with (d,p) results alone. Some gamma-gamma coincidence results using a Ge(Li) detector are reported. The conversion coefficients and multipolarities are analyzed from these and other results. The inter-level transition locations are discussed but not resolved. (auth)

13888 (^{3}He,3nγ) REACTIONS ON Te, Sn, AND Cd ISOTOPES. Betigeri, M. G.; Morinaga, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A95: 176-84(1967).

Low-energy gamma rays following compound nuclear reactions (^{3}He, 3n) on Te, Sn, and Cd isotopes were studied with a Ge(Li) counter at incident energies up to 19.3 MeV. Based on the systematics, the levels at 602 and 1160 keV in ^{118}Te were assigned to be the 2^+ and 4^+ levels. Similarly the level at 607 keV in ^{116}Te was assigned to be 2^+. Gamma rays corresponding to the transitions connecting lower-spin states at higher excitations were not observed. The success in observing higher-spin states, therefore, depends not merely on the higher angular momentum brought in by the incident particles but rather on the (2J + 1) weight factor for the higher-spin states, which is characteristic of any compound-nuclear reaction. (auth)

13889 APPLICATION OF THE GREEN FUNCTION METHOD TO THE NUCLEI ^{90}Zr AND ^{86}Kr. Mulhall, Walter J.; Liotta, Roberto J. (Centro Atomico Bariloche, Argentina. Balseiro Instituto de Fisica, San Carlos de Bariloche, Argentina). Nucl. Phys., A95: 161-75(1967).

The two-particle Green function method in the ladder approximation (LA) is used to study the effects of ground state pair correlation in the low-lying states of ^{90}Zr and ^{86}Kr, when the nucleus ^{88}Sr is taken as the core. An appreciable effect is found in the 0^+ states. For comparison, shell-model results are quoted. The calculations in the LA account for the binding energies of ^{90}Zr and ^{86}Kr, the energies of the excited 0^+ and 2^+ state and the mean life of the 2^0+ state, in ^{90}Zr. (auth)

13890 ROTATIONAL BANDS IN ^{182}Ta. Bizzarri, B.; Nunberg, P.; Prosperi, D. (CNEN, Rome). Nuovo Cimento (10), 46B: 13-34(Nov. 11, 1966).

The decay of the 16-min isomer ^{182}Ta^m was examined in order to look for previously undetected transitions and to obtain further evidence on the multipolarities of the known transitions. The γ-ray and conversion-electron spectra were measured. In agreement with a previous result by Sunyar and Axel it was found that the decay scheme of the isomer involves three states at excitation energies of 147.0 ± 0.3, 319.1 ± 0.6, and 504.6 ± 1.2 keV. If the ground-state activation cross section is taken to be 21b, the corresponding value for the isomer is 13 ± 2 mb. The half life is $T_{\frac{1}{2}}$ = 15.84 ± 0.10 min. An attempt is made to fit all the presently known data on ^{182}Ta into a single level scheme. The experimental results obtained by the decay of the isomer and by ^{181}Ta(d,p) reactions were compared with the predictions of the unified model. The relative positions of the rotational bands in ^{182}Ta are strongly affected by the properties of the effective (n,p) residual interaction introduced in the calculation. (auth)

13891 DELAYED GAMMA EMISSION IN THE FISSION OF ^{235}U. Popeko, L. A.; Val'skii, G. V.; Kaminker, D. M.; Petrov, G. A. J. Nucl. Energy: Pt. A and B, 20: 811-19(Sept. 1966).

The delayed γ emission from fission fragments in ^{235}U fission was studied over the time range of 10 to 70 nsec and in the energy interval 30 to 500 keV. The spectrum of the delayed radiation was found to be similar to that of the prompt radiation. However, the γ-ray yields were quite different and they were also inconsistent with the lifetimes obtained by Sklyarevskii et al. [Zh. Eksp. Teor. Fiz. 32: 256(1957)]. It is supposed that the prompt and delayed γ radiation in the interval 0 to 450 keV corresponds mainly to transitions between the low-lying levels of the same fragment nuclei but, in the case of the delayed radiation, the decay of one or more isomeric levels lying a little higher up is involved. (S.F.L.)

13892 PROPERTIES OF SOME EXCITED STATES OF ^{174}Yb. Barone, A. (Univ., Naples); Greco, G.; Speranza, R.; Ricci, R. A.; Blasi, P.; Maurenzig, P. R.; Sona, P. Nuovo Cimento (10), 46B: 134-6(Nov. 11, 1966).

The energy levels of ^{174}Yb were investigated by measuring the gamma spectrum from the decay of ^{174}Lu. The results are consistent with the assignment of 7^- to the 1518-keV level of ^{174}Yb. (D.C.W.)

13893 MEASUREMENT OF THE ACTIVITY OF ELECTRON-CAPTURE SOURCES BY THE K AND L X-RADIATION COINCIDENCE METHOD. Konstantinov, A. A.; Sazonova, T. E. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/69, 4p. (In Russian). (CONF-661012-35). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A method was developed for determining the activity of pure electron-capture sources by K and L x-ray coincidence. A scintillation counter is used for detecting the K x radiation and a proportional counter is used for detecting the L x radiation. In the case of ^{159}Dy, ^{145}Sm, and ^{139}Ce, a scintillation spectrometer is used for detecting both. The accuracy of this method depends on the angular correlation between the K and L x radiation. There is at present no experimental information concerning the angular correlation of K and L x radiation, but theory predicts such a correlation. This effect is therefore also being studied. (auth)

13894 SPONTANEOUS FISSION HALF-LIVES OF ^{242}Cm AND ^{244}Cm BY ABSOLUTE ALPHA AND NEUTRON COUNTING. Armani, Roland J.; Gold, Raymond (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/53, 8p. (CONF-661012-30). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Spontaneous fission half lives of ^{242}Cm and ^{244}Cm were determined by absolute alpha counting and the measurement of spontaneous fission neutrons. Sources in the 1 to 10 mCi range were prepared by electroplating onto platinum planchets. The absolute alpha activity was determined to better than 0.5% relative error by employing a special low geometry counter. The spontaneous fission neutrons were detected with a lithium iodide crystal scintillator 95.6% enriched in ^{6}Li. High neutron detection efficiency was obtained by centering the crystal and sources in a neutron-moderating medium (H_2O or D_2O). Absolute calibration of this system was determined with a ^{252}Cf spontaneous fission neutron source which was prepared and counted in a manner identical to the curium sources. The results obtained are $6.09 \pm 0.18 \times 10^6$ yr and $1.33 \pm 0.03 \times 10^7$ yr, respectively, for the spontaneous fission half lives of ^{242}Cm and ^{244}Cm. The present method is compared to the customary measurement of spontaneous fission half lives obtained by fission fragment and alpha counting. (auth)

13895 RADIATIVE CAPTURE CROSS SECTIONS FOR FAST NEUTRONS FOR Ag, Dy, Ta, W, AND Re. Kononov, V. N.; Stavisskii, Yu. Ya.; Chistozvonov, S. R.; Shorin, V. S. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/99, 8p. (In Russian). (CONF-661014-36). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Capture cross sections for 30 to 170 keV neutrons were measured for the isotopes ^{107}Ag, ^{109}Ag, ^{161}Dy, ^{162}Dy, ^{164}Dy, ^{182}W, ^{184}W, and ^{186}W and a natural mixture of Ta, W, and Re isotopes. The neutron capture events were recorded by a liquid scintillation detector measuring the prompt capture gamma rays. The measurements were carried out on a Cockcroft-Walton pulsed accelerator, using a nanosecond time-of-flight technique for discriminating the background and measuring the neutron energy. (auth)

Nuclear Theory

Refer also to abstracts 12373, 12626, 13687, 13742, 13798, 13807, 13826, 13843, 13848, 13865, and 13868.

13896 (IS-1501) SMASH: A NEW APPROACH TO DECAY-RESOLUTION PROBLEMS. Korthoven, P. J. M.; Carlsen, F. S. (Ames Lab., Iowa). Jan. 1967. Contract W-7405-eng-82. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer program SMASH for the resolution of radioactive decay curves is described. It involves a direct-search method for obtaining unknown half lives, combined with a linear least-squares procedure for the calculation of the count rates of the species present. In many cases, the use of the direct-search method has proven to be more successful and to supply more information about the decay problem than the nonlinear least squares procedures used in most other programs of this kind. A description of the performance of the program and the reliability of results obtained in extensive testing of the various routines is included. (auth)

13897 (NP-16431) ESTUDIO DE LAS RESONANCIAS EN LA DISPERSION ELASTICA. (Studies of Resonances in Elastic Scattering). Fierros Palacios, Angel (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1966. 49p. (In Spanish). Dep. mn.

Thesis.

The resonances in elastic scattering are studied using as a model a particle being moved at an effective potential. The procedure is as in the Feshbach, changing the many-body system to a single-particle system which is moved at a common potential. Formally this situation is described by a system of coupled differential equations. It is assumed as in boundary condition theories that there exists a region of interaction from which the particle is free. By use of the logarithmic derivative method, a formal solution of the problem is indicated and it is shown that resonances described by formulas of the Breit-Wigner type exist. The relations of these solutions with those of Wigner are studied. The results are illustrated with a central example: the case of a particle with two possible channels, whose interaction is represented by potentials which can be squared in both channels and whose coupling is made only at the surface. (tr-auth)

13898 (ORNL-4002) A METHOD OF REPRESENTING TWO-DIMENSIONAL DISTRIBUTIONS FOR USE IN MONTE CARLO CALCULATIONS. Leimdorfer, M.; Barish, J. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In an attempt to increase the efficiency of an existing Monte Carlo program, the Nucleon Transport Code (NTC), for treating the transport of high-energy nucleons in matter, a method has been developed which is intended to improve the procedure for selecting combinations of the energy and angle of particles released in nuclear interactions. In the present form of NTC, the process of particle emission from nucleon-nucleus collisions is simulated by a Monte Carlo treatment of the intranuclear cascade. In the proposed method, the particle emission data obtained from the intranuclear cascade calculations are represented in the form of tables which are suitable for sampling purposes. The power of the method lies in the fact that the tables are constructed directly from the intranuclear cascade (Monte Carlo) histories. (auth)

13899 (USNRDL-TR-1093) BETA SPECTRA. III. SPECTRA OF ^{235}U FISSION PRODUCTS AT SELECTED TIMES AFTER FISSION. Hogan, O. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 3, 1966. Contract AT(49-5)-2505. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Composite beta spectra for mixed fission products of ^{235}U were computed as the weighted sum of the theoretical beta spectra of the individual emitters. Reactor operating times used were: 0, 30, 60, 120, 240, 480, and 960 sec, and 1 year. Sixteen decay times between 10^3 and 10^8 sec were used. Results are graphically presented and are considered accurate to within 15% for decay times less than 10^4 sec, and to within 5% for times greater than 10^4 sec. (auth)

13900 DERIVATION OF THE VAN KAMPEN'S CAUSALITY CONDITION FOR COMPLEX POTENTIALS AND RELATED PROBLEMS. Aly, H. H. (American Univ. of Beirut); Okubo, S. Z. Phys., 200: 20-8(1967).

Following a method originally due to Saavedra, Van Kampen's causality condition for scattering by complex potentials was derived. Together with this problem, both Wigner inequality and Levinson theorem are also discussed in the context of scattering by regular and singular complex potentials. (auth)

13901 INTEGRAL EQUATION METHOD FOR TREATMENT OF SCATTERING ON BOUND PARTICLES. Kerler, Werner (Univ., Marburg, Ger.). Z. Phys., 200: 36-56(1967). (In German).

It is pointed out that various methods known for the treatment of multi-particle scattering problems such as the methods of Lax, Watson, and Faddeev are based on the same type of T-operator equations with eliminated interactions. They only differ by the identification of the interactions. An integral equation treatment for the scattering of a particle by a system of n bound particles is developed. If the scattering occurs via local two-body forces, the interaction matrix element splits into that of the two-particle case and a momentum-dependent factor. This fact is used to simplify the scattering equations which then get a mathematical structure similar to that of T-operator equations involving sums of bound states rather than sums of interactions and which, therefore, can be handled in a similar way. When the interactions are eliminated by means of the two-particle scattering amplitudes, the off-shell energy parameter of these amplitudes may be chosen to be dependent on quantum numbers of the bound system. Such a choice shows indeed to be favorable if one likes to keep only the lowest order approximation of the integral equations. The resulting approximate formula leads, after some further approximations, for resonant scattering to a formula of Lamb, and for weakly energy-dependent amplitudes to a formula of Fermi (being related to the impulse approximation). The resonant scattering formula is applied to a quantum-mechanical derivation of a method for the determination of nuclear lifetimes which had been proposed on semi-classical arguments by Ciocchetti et al. Finally the method developed for the scattering of a particle by a system of bound particles is extended to collisions between composite particles. (auth)

13902 EQUIVALENT TWO-BODY POTENTIALS. Heintzmann, H. (Univ., Cologne). Z. Phys., 200: 29-35(1967).

The consequences of the existence of a bound state in a local nuclear two-body potential for charge distribution, inelastic scattering, photodisintegration, and saturation are investigated. (auth)

13903 EQUIVALENT WIDTH ON THE MOESSBAUER SPECTRUM. Yoshioka, T.; Kohno, H. (Tokyo Shibaura Electric Co., Ltd.). Nucl. Instrum. Methods, 48: 193-6(1967).

An equivalent width is introduced in the Mössbauer spectroscopy. It is given by the ratio of measured area and measured absorption depth. It is obtained without the correction of the background counting rates. Since the equivalent width is independent of the recoilless fraction of the source, it may be applied to the quantitative analysis of the resonant absorber, provided that the instrumental broadening is calibrated experimentally. (auth)

13904 MAXIMUM-LIKELIHOOD ESTIMATORS FOR THE PARAMETERS OF LIFETIME EXPERIMENTS. Wenzelburger, H. (Univ., Frankfurt am Main). Nucl. Instrum. Methods, 48: 341-3(1967).

It is shown that the two parameter gamma-frequency function $p_1(t) \cdot dt = [B^\nu/(\nu-1)!]t^{\nu-1}e^{-\beta t}dt \equiv p_1(t;\nu,\beta)dt$, where $0 \leq t < \infty$ and ν is an integer, can give in many cases a sufficiently good approximation for experimental prompt lifetime frequency functions. (B.G.D.)

13905 STIFFNESS OF FISSION FRAGMENTS. Honda, Takao (Yamanashi Univ., Kofu, Japan). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 451-7(1966).

The steep rises of the stiffness of fission fragments near N = 50 and Z = 50 (or N = 82) closed shells are assumed to be ascribed to variation of the surface tension from nucleus to nucleus. The deformation energy of the fragments at scission and the average total kinetic energy of the fragment pair are calculated by using the tangent spheroid approximation of two deformed liquid drops. General tendencies of the low-energy fission, such as Terrel's universal curve of the prompt neutron numbers and the salient dip

of the total kinetic energy of fragment pair in the symmetric region of mass splits, are qualitatively reproduced. (auth)

13906 DETERMINATION OF EQUIVALENT NUCLEON–NUCLEON POTENTIALS AND INDUCED MANY-BODY FORCES IN MANY-BODY SYSTEMS. Ristig, Manfred (Univ., Cologne). Z. Phys., 199: 325-48(1967). (In German).

The local nucleon-nucleon potential, which contains a hard core, is transformed into a nonlocal, but regular, equivalent potential. The canonical transformations used are restricted to the group of point transformations with infinitesimal generators which depend linearly on the momentum operators of the particles and which preserve the invariance properties. An especially simple one-parametric class of such isometric transformations is chosen, and the method is then applied to the many-body problem. A formal expression is given for the induced many-body forces. It is pointed out that in the "linear" and "asymptotic" approximation there is only an induced static three body force and its form is given explicitly. (auth)

13907 TIME-DEPENDENT CORRELATIONS IN NUCLEI. Quarati, P. (Univ., Cagliari, Italy). Nuovo Cimento (10), 47B: 124-6(Jan. 11, 1967).

The time-dependent N-N correlations that can be obtained from the multipole electromagnetic electron-nucleus interaction are studied. It is shown that the Fourier transform of the time-dependent multipole correlation function can be obtained from the differential electron inelastic scattering cross section. (D.C.W.)

13908 NUCLEAR SPIN RELAXATION IN A ROTATING TILTED REFERENCE FRAME. Clough, S. (Univ. of Pittsburgh). Phys. Rev., 153: 355-7(Jan. 10, 1967).

The theory of Provotorov for the rate of approach to equilibrium in nuclear-magnetic-resonance saturation is extended to stronger saturating fields following a method used previously by Walstedt, but avoiding his Gaussian assumption for a spectral density function. It is shown that the function may be very far from Gaussian. Provotorov's result, valid for weak-saturating fields only, is placed on a better foundation by showing that it depends only slightly on the decomposition of the Hamiltonian resulting from the choice of reference frame. (auth)

13909 NUCLEAR MATTER CALCULATIONS WITH SOFT-CORE POTENTIALS IN MOMENTUM SPACE. I. Harada, Minoru; Tamagaki, Ryozo; Tanaka, Hajime (Otaru Univ. of Commerce, Japan. Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 36: 1003-13(Nov. 1966).

The reaction matrix equation of the Brueckner theory is solved self-consistently in momentum space for S-state interactions with a soft core. The calculated binding energy ranges from 9.8 MeV at the equilibrium spacing of 1.03 fm to 12.1 MeV at 0.88 fm as the soft core strength is varied. An exact treatment of off-energy-shell propagation proposed by Brueckner and Gammel is found to reduce the binding energy by less than 0.2 MeV as far as the S states are concerned. (auth)

13910 FOCK APPROXIMATION IN THE FIELD METHOD OF THE MANY BODY THEORY IN THE CASE OF UNFILLED SHELLS. Kamuntavichyus, G. P.; Shugurov, V. K. (Kapsukas Stat Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 207-13(1966). (In Russian).

A field method is presented for obtaining the Hamiltonian in Fock approximation for the many-body problem in the case of unfilled shells. Agreement between theory and experiment, and perturbation methods are discussed. (auth)

13911 CENTRAL INTERNUCLEAR INTERACTION IN IRREDUCIBLE FORM. II. CLEBSCH–GORDAN COEFFICIENTS FOR THE SYMMETRICAL GROUP. Vanagas, V. V.; Petrauskas, A. K. (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 181-90(1966). (In Russian).

The method of calculation of the Clebsch–Gordan coefficients for the symmetrical group S_n is discussed. Concrete expressions of these coefficients for the representations, which are used on calculating the energy matrix for the interpretation in irreducible form for the most symmetrical orbital states of atomic nuclei are presented. (auth)

13912 CENTRAL INTERNUCLEAR INTERACTION IN IRREDUCIBLE FORM. III. SYMMETRICAL GROUP IRREDUCIBLE EXCHANGE OPERATORS, SUBMATRICES, AND INVARIANTS. Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 191-9(1966). (In Russian).

The method of calculation of the symmetrical-group irreducible exchange operators, submatrix, and invariants used for determination of the matrix of central internuclear interaction is discussed. The tables of those values for the most symmetrical orbital states of the light nuclei are presented. (auth)

13913 GROUND CONFIGURATION ENERGY SPECTRUM OF THE ^{18}O AND ^{18}F NUCLEUS IN THE SHELL MODEL. Jucys, A. A.; Vanagas, V. V.; Rakauskas, R. I. (Polytechnic Inst. of Kaunas, Vilnius, USSR. Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR. Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 201-6(1966). (In Russian).

The parameters of two-particle interaction in the intermediate coupling scheme approximation for the ground configuration $(sd)^2$ of the ^{18}O and ^{18}F nuclei presenting the spectrum near the experimental values are found. Theoretical results are compared with the experimental numbers. (auth)

13914 INVESTIGATION OF THE EFFECTS OF A SPIN–SPIN INTERACTION ON THE ELASTIC SCATTERING OF NEUTRONS BY NUCLEI. Stamp, A. P. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 153: 1052-60(Jan. 20, 1967). (MIT–2098-242).

The effects of an interaction between the spin of the incident neutron and the spin of the target nucleus are considered in the framework of the optical model. It is found that the differential elastic scattering is insensitive to the interaction. However, the interaction splits the single-particle states, and the elastic scattering shows structure as a function of energy when the absorption is small. The spin-spin interaction has a negligible effect on the polarization. The rotation parameter $R(\theta)$ and the asymmetry parameter $A(\theta)$ are sensitive to the spin-spin interaction for $\theta = 180$ and 90°, respectively. For angles near the minima in the differential elastic scattering, the depolarization is approximately zero. (auth)

13915 CORE-POLARIZATION EFFECTS IN SINGLE-NUCLEON-TRANSFER REACTIONS. Bansal, Ram K. (Univ. of Rochester, N. Y. Michigan State Univ., East Lansing). Phys. Rev., 153: 1084-90(Jan. 20, 1967).

An attempt was made to understand the effects of the core polarization, when a particle (proton, in the present case) is added to an inequivalent orbit and a core having a closed neutron shell. These effects show up in the spectrum of the residual nucleus in the form of the fragmentation of the strength of the lower isobaric-spin single-particle state, as was confirmed by the measurements of Armstrong et al. and Erskine et al. via (^{3}He,d) reactions. Particular cases involving the addition of an inequivalent proton to ^{48}Ca and ^{36}S are discussed. The inequivalent two-body interaction is determined, using the constraints given by the linear energy-weighted partial sum rules, and the hole-particle and particle-particle spectra of ^{56}Co and ^{36}Cl, respectively. (auth)

13916 PHENOMENOLOGICAL Λ-NUCLEON POTENTIALS FROM S-SHELL HYPERNUCLEI. I. DEPENDENCE ON HARD-CORE SIZE. Herndon, R. C. (Univ. of California, Livermore); Tang, Y. C. Contract W-7405-eng-48. Phys. Rev., 153: 1091-9(Jan. 20, 1967). (UCRL-70053).

The binding-energy data of the s-shell hypernuclei and the total cross sections of the Λ-proton scattering are examined with two-body, spin-dependent, charge-independent, central Λ-nucleon potentials which have an intrinsic range of 1.5 F and a hard core with a radius of 0, 0.3, 0.45, or 0.6 F. The main purpose is to see whether there exists a hard core in the Λ-nucleon interaction. The results show that a hard core very likely does exist and has a radius greater than about 0.3 F. Also, it is found that even when the hard-core radius is as large as 0.6 F, the Λ-nucleon interaction is not strong enough to bind together a two-body Λ-hypernuclear system. However, it does seem to be strong enough to allow the formation of a particle-stable excited state in the hypernucleus $_{\Lambda}H^4$ with a small binding energy. (auth)

13917 SOME EFFECTS OF PARITY NONCONSERVATION IN NUCLEAR ELECTROMAGNETIC DECAYS. Carhart, R. A. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 153: 1077-83(Jan. 20, 1967). (BNL–10431).

The matrix elements for decay of a nucleus by γ emission or electron conversion are considered with relaxation of the usual parity selection rules. Four types of pseudoscalar observables are calculated assuming, in particular, mixed ML and EL multipole matrix elements with arbitrary relative amplitude. These are γ-ray nuclear polarization with unpolarized initial and final nuclei, γ-ray angular distribution (terms odd in $\cos\theta$) with polarized initial nucleus, helicity of conversion electrons with unpolarized initial and final nuclei, and circular polarization of the

succeeding γ ray relative to the direction of the first, mixed-parity γ ray in the two-photon cascade of an unpolarized nucleus. A proof is presented that the helicity of the conversion electron approaches the circular polarization in the mathematical limit of infinite transition energy. Numerical results are presented for ^{180m}Hf based on a recent conjecture of parity mixing in one of its transitions. (auth)

13918 REMARKS ON VARIATIONAL BOUNDS IN SCATTERING THEORY. Hahn, Yukap; Spruch, Larry (New York Univ.). Phys. Rev., 153: 1159-64(Jan. 20, 1967).

The lower variational bound on the eigenphase shifts obtained by Sugar and Blankenbecler (SB) is shown to be formally equivalent to the upper variational bound $(K^{-1})_{up}$ on the inverse of the reactance matrix K^{-1} that had been obtained earlier. By formally equivalent we mean that if the identical trial function is used in the two formulations, the eigenphase shifts contained in $(K^{-1})_{up}$ are identical with those determined by the SB formulation. A still more recent variational bound by Rosenberg (R) is shown to be identical, for most purposes, to the SB result, and therefore also formally equivalent to the original variational bound. The SB and R approaches may nevertheless have certain advantages, since they suggest different actual numerical procedures. A lower variational bound on K^{-1} is obtained by means of the SB technique for determining upper bounds on the eigenphase shifts. (auth)

13919 LIMITATION OF THE NUMBER OF DEGREES OF FREEDOM IN FLUCTUATION ANALYSIS. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 153: 1206-8(Jan. 20, 1967). (LA-DC-7961).

The limitation on the effective number of degrees of freedom (N_{eff}) due to the possibility that a finite number of statistically independent terms makes up the different amplitudes is considered. A general simple model is considered which leads to a simple expression for N_{eff}. A more detailed calculation is made in which it is assumed that independence is associated only with different values of J and π. This last calculation is shown to give some improvement over previous calculations. (auth)

13920 NORMAL MODES OF OSCILLATION OF A UNIFORMLY CHARGED DROP ABOUT ITS SADDLE-POINT SHAPE. Nix, James Rayford (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 41: 52-107(Jan. 1967). (UCRL-16786).

The normal modes of oscillation of an idealized uniformly charged axially symmetric liquid drop about its saddle-point shape are considered and the normal modes and their frequencies are calculated as functions of the fissility parameter x. Both expansions to first order in $1 - x$ and formulas appropriate for numerical evaluations are derived. For the range $0.7 \leq x \leq 1.0$ numerical results for the four lowest symmetric and the four lowest asymmetric modes are tabulated at intervals of 0.02 in x for the frequencies, normal-coordinate stiffness and inertia constants, and eigenvectors (with respect to the coefficients α_n in an expansion of the drop's radius vector in Legendre polynomials). For $0.3 \leq x < 0.7$ the results obtained are of limited accuracy, and in this range only graphs of the frequencies of the 3 lowest symmetric modes are included. Some applications of the results are discussed. These include the transition-state energy levels of collective oscillations, the probability distributions for the saddle-point states of motion, and the penetration of the fission barrier. The formula for the penetrability of a cubic barrier is derived by use of the WKB approximation. The calculated (purely imaginary) frequency for motion in the fission direction, which affects the penetrability of the fission barrier, is compared as a function of x with existing experimental data on fission widths, spontaneous-fission lifetimes, and the variation of fission cross sections with excitation energy. The comparison, which is made without the use of any adjustable parameters, indicates that the calculations are capable of reproducing the correct order of magnitude of the fission-direction frequency. Most of the data are at present not sufficiently accurate to provide a sensitive test of the theory, but the points derived from spontaneous-fission lifetimes suggest that possibly 2.8 times as much mass is displaced in the fission mode as would correspond to irrotational motion. (auth)

13921 COHERENCE WIDTH OF CROSS-SECTION FLUCTUATIONS AND MAXIMA IN THE EXCITATION FUNCTION. Bizzeti, P. G.; Maurenzig, P. R. (Univ., Florence). Nuovo Cimento (10), 47B: 29-38(Jan. 11, 1967).

The number of maxima in the excitation function was calculated (in the overlapping level region) as a function of the distance ϵ_0 between two consecutive experimental points and of the fluctuation width Γ. The calculation was made for the two limiting cases of one single channel and of many contributing channels. In contrast with some previous results the values of the proportionality factor b_N come out to be the same in the two cases; its limit value for $\epsilon_0/\Gamma \to 0$ is found to be 1.10, in agreement with a recently reported value and at variance with earlier results. Finally a criterion to avoid spurious maxima due to experimental errors is proposed and discussed quantitatively. (auth)

13922 DWBA IN DEUTERON STRIPPING REACTIONS WITH SPIN-ORBIT DISTORTIONS. Cirelli, R. (Univ., Milan, Istituto Nazionale di Fisica Nucleare, Milan); Marini, A.; Gulmanelli, P. Nuovo Cimento (10), 47B: 39-55(Jan. 11, 1967).

The differential cross section and the polarization in deuteron stripping reactions are derived in the framework of the DWBA model taking the spin-orbit distortions on the outgoing nucleon as well as on the incoming deuteron (expressed in terms of nucleon spin-orbit potentials) into account to the first perturbative order. The results of numerical computations of the polarization made for some typical reactions at different energies and with different choices of the optical parameters are presented. (auth)

13923 ATOMIC AND NUCLEAR MODELS. Gamba, A. (Univ., Genoa). Phys. Lett., 24A: 64-5(Jan. 2, 1967).

It is shown that close-packed-spheres models, on the basis of quantum mechanics, are far more realistic than the usually accepted picture, which is based on the shell model. (auth)

13924 ON THE DESCRIPTION OF LOW-ENERGY NUCLEAR RESONANCES WITH THE HELP OF QUANTUM GREEN'S FUNCTIONS. Werner, E. (Technische Hochschule, Hanover). Z. Phys., 198: 241-50(1967).

It is shown that the appearance of low-energy nuclear resonances in the elastic channel can be described using quantum Green's functions. After the development of the general theory, a model is sketched which can be used to perform explicit calculations. (auth)

13925 EXPLICIT FORMS FOR SCATTERING TRANSFORMATION MATRICES $T^n_{LL'}$. Harris, D. R. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 26: 559-62(Dec. 1966).

Explicit forms for the scattering transformation matrices are derived. (D.C.W.)

13926 THREE-PARTICLE MODEL FOR A DEUTERON OPTICAL POTENTIAL CALCULATION. Jaffe, A. I.; Reiner, A. S.; Ventura, J. E. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A95: 235-40(1967).

An optical potential which describes the elastic scattering with infinite energy resolution of deuterons from a nucleus is determined from a three-particle model. (auth)

13927 STRETCHED X-COEFFICIENTS. Sharp, R. T. (Univ. of Illinois, Urbana). Nucl. Phys., A95: 222-8(1967).

The simplifications that occur in the expressions for the X-coefficient when one or more of the triangles comprising it are stretched are considered. Older results are presented with the new ones for completeness and comparison. (auth)

13928 ON NOGAMI'S IMPROVED SUPERCONDUCTIVITY APPROXIMATION. Bloore, F. J. (Univ. of Liverpool). Nucl. Phys., A95: 185-92(1967).

Nogami's refinement of the variational treatment of the pairing Hamiltonian of Bardeen, Cooper, and Schrieffer is discussed further. On the assumption that the minimum wave function is a combination of ground-state wave functions with different numbers of particles, it is found that although the prescriptions of Nogami for the parameters λ_1 and λ_2, which appear in the quadratic formula for the ground-state energy as a function of particle number, do not necessarily lead to the correct values of λ_1 and λ_2, his prescription for the ground-state energy is still correct. (auth)

13929 INVESTIGATION OF THE SEPARATION ENERGIES OF LIGHTER NUCLEI. Haque, K. B. (Univ. of Birmingham, Eng.); Valatin, J. F. Nucl. Phys., A95: 97-114(1967).

Separation energies of nuclei for $A \leq 100$ and derived quantities are presented in a form in which similarities and differences in the data for the lightest nuclei can be easily assessed. The initial data are completed by a fair number of separation energies which can be derived from tabulated values. The rather constant trend in the energy needed to separate a proton and a neutron simultaneously is pointed out. The effect of additional protons and neutrons on the separation energies is investigated. The diagrams show a regular part and a special part related to nuclei with N = Z or nearby. The special parts can be analyzed in terms of the additional binding energy related to the symmetry of these nuclei. Pairing-energy diagrams are given which show a smooth and regular behavior down to the lightest nuclei. (auth)

13930 SOME STUDIES OF THE EFFECTIVE INTERACTION FOR THE INELASTIC SCATTERING OF NUCLEONS. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A95: 1-37(1967). (ORNL-P-2778).

The microscopic interpretation of the inelastic scattering of nucleons by nuclei is reviewed. Data for (p,p'), (nn'), and (p,n) reactions at medium energies on nuclei with simple shell-model configurations are analyzed in terms of a simple effective nucleon-nucleon interaction. In many cases, a local Yukawa interaction with a range of about 1 fm, a strength about 200 MeV, and a weak spin dependence is found to give fair agreement with the data. Discrepancies are also found, particularly for the heavy nucleus ^{208}Pb and for the inelastic polarization of protons. Possible deficiencies of the model are discussed in some detail. Exchange effects of the knock-on type are neglected. (auth)

13931 NUCLEAR STRUCTURELESS INTERNAL CONVERSION PARTICLE PARAMETERS IN THE K- AND L-SHELLS. Hornshoej, P.; Deutch, B. I.; Miranda, A. (Univ. of Aarhus, Denmark). Nucl. Phys., A95: 65-79(1967).

The normal "structureless" particle parameters are examined theoretically and experimentally. The results of calculations showing the agreement between finite-size and point-nucleus L-subshell particle parameters for M1, E1, and E2 transitions are given. The L_3 subshell interference particle parameters b_2(M1 + E2) and b_2(E1 + M2) in the region $49 \leq Z \leq 98$, calculated with finite-size (screening corrected) radial matrix elements, are presented. For the L_3 shell, the b_4 particle parameters for M2 and E2 multipoles are also given. The point-nucleus model has been used for calculating the L-subshell particle parameters for E3 and M4 multipoles. For these multipoles, tables are given for Z = 49, 77, and 98 in the energy range $0.1 \leq k \leq 0.7$. The use of the L-shell particle parameters and particle-parameter ratio $b_2(K)/b_2(TL)$ for the determination of the mixing amplitude δ and the sign of δ is discussed. (auth)

13932 TREATMENT OF HARD CORE IN SHELL MODEL CALCULATIONS. Banerjee, B.; Parikh, J. C.; Rao, Y. S. T. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A94: 481-90(1967).

Various methods of treating the hard core in a finite nucleus are examined, by carrying out a shell model calculation for the ^{18}O nucleus, using the hard-core potential of Kallio and Kolltveit. The energies and the wave functions of the 0^+, 2^+, and 4^+ states in ^{18}O are calculated. A comparison of the matrix elements in the three methods is made, and the effectiveness of each method in taking into account the hard core is discussed. (auth)

13933 SURFACE DELTA INTERACTION AND NONROTATIONAL COLLECTIVE STATES IN RARE-EARTH NUCLEI. Faessler, Amand; Plastino, Angel (Univ. of California, Los Angeles). Nucl. Phys., A94: 580-92(1967).

The surface delta interaction (SDI) was applied to a calculation of the γ- and K = 0 octupole vibrational states in the rare-earth region. The residual interaction used has only one parameter, which can be determined by means of the odd-even mass differences, while the pairing plus quadrupole (or octupole) model utilized for this type of calculation requires three essentially unrelated coupling strengths. The results obtained compare reasonably well with the experimental ones, being in this sense as good as those yielded by the pairing-plus-quadrupole (or octupole) model. (auth)

13934 FINITE-RANGE CORRECTIONS FOR STRIPPING REACTIONS. Smith, William R. (Oxford Univ.). Nucl. Phys., A94: 550-60(1967).

The effective-mass and local-energy approximations are studied to determine whether useful finite-range corrections to zero-range stripping calculations can be obtained that are more accurate than those presented previously. It is found that second-order effective-mass approximation results are quite practical, whereas the local-energy approximation does not lead to useful expressions more accurate than the first-order effective-mass results. However, the local-energy approximation may be employed for evaluating integrals occurring in strong coupling re-arrangement collision calculations. (auth)

13935 THE FUNDAMENTALS OF β-DECAY THEORY. Blin-Stoyle, R. J.; Nair, S. C. K. (Univ. of Sussex, Eng.). Advances Phys., 15: 493-545(Oct. 1966).

A brief review of the fundamentals of beta-decay theory is presented. An attempt is made to show how the elementary-particle interaction responsible manifests itself. 103 references. (D.C.W.)

13936 Λ-Λ INTERACTION FROM $^{6}_{\Lambda\Lambda}$He. Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Nuovo Cimento (10), 46B: 117-24(Nov. 11, 1966).

The strength of the Λ-Λ interaction in the $^1S_0$ state was determined by an analysis of $^{}_{\Lambda\Lambda}$He^6 using an α + 2Λ model for $^{}_{\Lambda\Lambda}$He^6 and a Λ-Λ potential with a hard core of radius 0.4 fm and an intrinsic range of 1.5 fm. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 12569, 13099, 13100, 13136, 13226, 13227, 13241, 14057, 14059, 14107, 14111, and 14121.

13937 (AAEC-E-160) AN EQUILIBRIUM MODEL FOR CALCULATION OF BURNUP IN A RECIRCULATING PEBBLE BED REACTOR. Bicevskis, A.; Hesse, E. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1966. 11p. Dep. mn.

Burnup calculations for pebble bed reactors are discussed. An efficient calculational scheme is developed by treating operation at equilibrium with a random distribution of pebbles. Assuming a constant flux level and spectrum, analytical solutions are obtained for time-averaged nuclide concentrations. With specified feed composition, average power density, and burnup, consistent values of average nuclide concentrations and flux spectrum are derived in an iterative manner. It is shown that the assumptions are justified for the large pebble bed reactors based on PuO_2-ThO_2-BeO fuels selected for a reactor feasibility study. A spectrum-weighted one-group treatment lends itself to efficient coupling of burnup and power plant optimization studies. (auth)

13938 (AAEC-TM-342) HEAVY WATER REACTOR CHEMISTRY STUDIES. PART I. ROLE OF NITROGEN. Ryan, H. F.; Smythe, L. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1966. 27p. Dep. mn.

Experiments were carried out in HIFAR with the ion exchange unit removed from circuit and N_2 levels of 0.2 and 1.5% in the gas circuit to study the rate of nitric acid formation, corrosion of Al and stainless steel components, radiolysis of the heavy water, and sources of CO_2 in the system. The rate of nitrate formation was found to be 137 mg/day and 244 mg/day at the lower and higher N_2 levels respectively. No increase of Al or stainless steel corrosion products in the moderator was observed as the nitric acid concentration increased. A possible mechanism for the corrosion of Al components in the system is discussed. An explanation is offered for the increase in the CO_2 level of the gas circuit observed in each experiment. A decrease in the rate of radiolysis of the heavy water occurred at higher N_2 levels. Many of the observations cannot be explained and further experiments are needed. (auth)

13939 (AD-629447) IS THE MARBLE CANYON PROJECT ECONOMICALLY JUSTIFIED. Carlin, Alan P.; Hoehn, William E. (RAND Corp., Santa Monica, Calif.). Feb. 1966. 27p. (P-3302(RAND)). CFSTI $3.00 cy, $0.65 mn.

A review of information resulting from economic studies of the Colorado River Marble Canyon Project is presented. Newer and more refined cost-benefit calculations on the project are included. The data suggest that the Marble Canyon Project is not justified since a nuclear alternative can generate the same electric power at lower cost. (J.R.D.)

13940 (AD-634455) CONTROL-CAB DESIGN FOR ML-1A NUCLEAR POWER PLANT: HUMAN ENGINEERING CONSIDERATIONS. Sova, B. Lawrence Jr. (Army Human Engineering Labs., Aberdeen Proving Ground, Md.). Oct. 1965. 102p. (TM-15-65). CFSTI $3.00 cy, $0.75 mn.

The human engineering considerations in the preliminary detailed design of the ML-1A control cab are summarized. Alternate designs for the cab interior and the cab sub-system are discussed and conclusions are presented. (auth)

13941 (AE-257) DANCOFF CORRECTION IN SQUARE AND HEXAGONAL LATTICES. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1966. 38p. Dep. mn.

The results of calculations of Dancoff corrections for square and hexagonal rod lattices are presented. The tables cover a wide range of volume ratios and moderator cross sections. The results were utilized for checking the approximative formula of Sauer and the modification of Bonalumi to Sauer's formula. The modified formula can be used to calculate the Dancoff correction with an accuracy of 0.01 – 0.02 in cases of practical interest Calculations were also performed on square lattices with an empty gap surrounding the rods. The results demonstrate the error involved in treating this kind of geometry by means of homogenizing the gap and the moderator. The calculations were made on a Ferranti Mercury computer. FORTRAN routines for Dancoff corrections were written, and a subroutine DASQHE is included. (auth)

13942 (AECL-2534(Rev.)) TRENDS IN ATOMIC POWER COSTS. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1966. 18p. (CONF-661003-16). Dep. mn. AECL $0.50.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

Real and estimated unit capital costs for nuclear plants in Canada, France, United Kingdom and the United States are normalized to costs for single 500 MW(e) plants in 1966 dollars. It is thus possible to determine cost trends excluding the effect of unit size and escalation. The reported plant efficiencies plus a factor which relates change in unit cost to change in efficiency permits the determination of the effect of increasing efficiency on the unit cost. Factors are proposed which will reduce the cost of energy from CANDU nuclear plants, and the contribution of each of these factors to this reduction is calculated for a particular case. The cost of energy from a 1000 MW(e) CANDU unit is predicted assuming the cost reduction factors proposed and commissioning of the unit in 1976. (auth)

13943 (AECL-2580) BOUNDARY CONDITIONS AT THE INTERFACE BETWEEN A LATTICE CORE AND A HOMOGENEOUS REFLECTOR. Stewart, J. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 26p. Dep. mn. AECL $1.00.

Calculations used to select the lattice core fluxes and currents to match to those in the reflector at the core-reflector interface are described. The critical value of the outside radius of the reflector for different sizes of hexagonal lattice core is calculated using two-group theory with cell-surface fluxes and currents; two-group theory with cell-average fluxes and currents; and conventional two-group theory and the microscopic-discrete method. In general the cell-surface method gives good results. (auth)

13944 (AECL-2830) SOME ENGINEERING ASPECTS OF THE CANADIAN NUCLEAR POWER PROGRAMME. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1966. 8p. (CONF-661036-1). Dep. mn. AECL $0.50.

From 3rd Congress of the Interamerican Confederation of Chemical Engineers, Mexico City, Mex.

The mechanical, civil, and chemical engineering problems encountered in the development of heavy-water-moderated natural-uranium-fueled reactors in Canada are briefly reviewed. (H.D.R.)

13945 (ANL-7222) AN ANALYTIC STUDY OF THE TRANSIENT BOILING OF SODIUM IN REACTOR COOLANT CHANNELS. MacFarlane, Donald R. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 117p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An analytic model was developed and used to perform calculations aimed at predicting the time-dependent behavior of boiling Na coolant in the channels of a nuclear reactor. Specifically, the information sought is a detailed description of the Na coolant density (vapor void fraction) in space and time during abnormal reactor operation which results in overheating and coolant boiling. Such information is necessary to calculate feedback reactivity effects in transient analyses of large (1000 MW(e)) fast breeder reactors. The approach taken was to seek solutions for the coupled, nonlinear, partial differential equations of fluid dynamics and heat conduction written for a single reactor coolant channel and fuel rod. Two basic types of transients were studied: mild overpower transients in which the driving function is an exponentially increasing heat generation rate in the fuel and coastdown of the coolant flow resulting from an exponentially decreasing available pressure head at the coolant channel inlet. These two cases correspond to the inadvertent insertion of reactivity and to coolant-pump failure, respectively. Numerical solutions were obtained for the nonlinear forms of the coupled partial differential equations by means of implicit finite difference equations and an iterative method in an ALGOL computer program. In a typical boiling transient the coolant entered the core hundreds of degrees below its boiling point, was heated to the boiling point in the channel, and exited from the channel with a high vapor void fraction. Results of calculations for a typical fast breeder configuration with UO_2 fuel rods and 50 v/o Na coolant led to the following general conclusions: the rate of coolant expulsion is extremely rapid once boiling starts and is sensitive to the coolant temperature profile in the liquid portion of the channel; the inlet flow decays rapidly to zero, typically by the time 20% of the channel is boiling; pressure buildup in the channel is not excessively large, typically less than 15 atm. Sonic effects and critical flow phenomena were not treated. However, the two-phase coolant density is pressure dependent, and a temporal and spatial varying liquid/vapor slip velocity is included. (auth)

13946 (ANL-7279) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, NOVEMBER 1966. (Argonne National Lab., Ill.). Dec. 21, 1966. Contract W-31-109-eng-38. 98p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Items of significant technical progress which have occurred in both the specific reactor projects and the general engineering research and development programs are summarized. Program activities are reported under five broad categories: Plutonium Utilization, Liquid-Metal Fast Breeder Reactors, General Reactor Technology, Advanced Systems Research and Development, and Nuclear Safety. The Experimental Boiling Water Reactor Pu recycle program is discussed under Plutonium Utilization. Liquid-Metal Fast Breeder Reactors includes the Experimental Breeder Reactor-II operations, fast zero-power assembly development, and fast reactor physics, components, and fuels development. General Reactor Technology examines applied and reactor physics, fuels and cladding, engineering, chemistry, and chemical separations. The Argonne Advanced Research Reactor development is summarized under Advanced Systems Research and Development. Nuclear Safety activities include coolant dynamics, fuel meltdown, materials behavior, energy transfer, Pu volatility studies, and TREAT operations. (H.D.R.)

13947 (ANL-7286) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, DECEMBER 1966. (Argonne National Lab., Ill.). Jan. 26, 1967. Contract W-31-109-eng-38. 92p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Items of significant technical progress which have occurred in both the specific reactor projects and the general engineering research and development programs are summarized. Program activities are reported under five broad categories: Plutonium Utilization, Liquid-Metal Fast Breeder Reactors, General Reactor Technology, Advanced Systems Research and Development, and Nuclear Safety. The Experimental Boiling Water Reactor Pu recycle program is discussed under Plutonium Utilization. Liquid-Metal Fast Breeder Reactors includes the Experimental Breeder Reactor-II operations, fast zero-power assembly development, and fast reactor physics, components, and fuels development. General Reactor Technology examines applied and reactor physics, fuels and cladding, engineering, chemistry, and chemical separations. The Argonne Advanced Research Reactor development is summarized under Advanced Systems Research and Development. Nuclear Safety activities include coolant dynamics, fuel meltdown, accident analyses, energy transfer, engineering safeguards systems, and TREAT operations. (H.D.R.)

13948 (BAW-393-9) THORIUM FUEL CYCLE FOR HEAVY WATER MODERATED ORGANIC COOLED REACTORS. Technical Progress Report No. 6, July–September 1966. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Nov. 1966. Contract AT(38-1)-393. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The activity on Phase II of the Thorium-HWOCR program during the period July through September 1966 is summarized. Work was conducted in specific portions of three major tasks: Reactor Engineering, Fuel Elements, and Recycle Technology. Reactor Engineering is the coordinating technical task for the program. It includes methods development, optimization studies, fuel management studies, control and safety analyses, economic analyses, and the technical coordination necessary to ensure the compatibility of the Th fuel elements with the Uranium-HWOCR design. The effort described was limited to methods development and analytical methods results are reported. Fuel Elements is the principle task under which all fuel element activity is conducted. Included are the following: fuel element design, fabrication development, and test program planning. The activity reported was limited to planning efforts in preparation for the Phase II program. Investigation and preliminary calculations performed in support of the detailed planning are presented. Recycle Technology is concerned with the reprocessing, feed materials preparation, and fabrication processes for the long-range condition of a mature industry and for the near-term condition of first plants on the line. Th–U fuel processing studies were continued, and an optimized reprocessing flow sheet for reference HWOCR fuel was prepared. In the course of preparing the final reprocessing flow sheet, the results of the Th fuel recovery operations recently conducted at the Savannah River and Hanford Purex process plants were evaluated. Also, a comprehensive review of the literature was made to ensure that adequate attention had been given to all recent developments in fuel reprocessing technology. (H.D.R.)

13949 (BMwF-FBK-66-20) UNTERSUCHUNG ZUR THEORIE DER NEUTRONENTHERMALISIERUNG IN EINER ZYLINDER-SYMMETRISCHEN ZWEI-ZONEN REAKTORZELLE. (An Investigation on Neutron Thermalization in a Cylinder-Symmetric Reactor Cell of Two Media). Kammerer, P. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Struktur der Materie). July 1966. 29p. (In German). Dep. mn.

In the framework of diffusion theory and heavy gas model an analytical solution is given for the space and energy dependent neutron flux. Spectra are calculated for the moderator zone (H_2O, D_2O) and inside the fuel rod (U). It is shown that diffusion theory is a fairly good approximation above $\epsilon = 1$ ($\epsilon = E/KT$), even inside the fuel rod. For energies beyond $\epsilon = 1$, it is concluded that the diffusion coefficient of the fuel cannot be assumed independent of energy. The energy dependence of ϵ is derived from numerically calculated spectra. (auth)

13950 (BNWL-CC-796) MULTIPLEXER CODES FOR THE PDP-7. Wilburn, N. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 24, 1966. Contract AT(45-1)-1830. 268p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A small digital computer (PDP-7) was interfaced to a low-speed relay multiplexer (2000 points/sec) and a high-speed solid-state multiplexer (240,000 points/sec). Details of the three codes which were written to operate these multiplexers and record the data collected onto magnetic tape, are given. (auth)

13951 (CEA-R-2884) ETUDE EXPERIMENTALE DES INSTABILITES HYDRODYNAMIQUES SURVENANT DANS LES REACTEURS NUCLEAIRES A EBULLITION. (Experimental Study of the Hydrodynamic Instabilities Occurring in Boiling-Water Reactors). Fabrega, Serge (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 15, 1964. 120p. Dep. mn.

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

Results of an experimental out-of-pile loop study of the hydrodynamic oscillations occurring in boiling-water reactors are presented. The study was carried out at atmospheric pressure and at pressure of about 8 atmospheres, in channels heated electrically. In the test at 8 atmospheres the channel was a round tube of approximately 6 mm ID. At 1 atmosphere a ring-section channel was used, 10 × 20 mm in dia, with an inner heating tube and an outer tube of Pyrex. It was possible to operate with natural convection and with forced convection using test-channel by-pass. The study is devoted to preliminary determination of the laws governing pressure-drop during boiling; determination of the fronts at which oscillation appears, within a wide range of the parameters involved; and a description of the oscillations and measurement of the periods. Data on the oscillation fronts are given with natural and forced convection for various values of the pressure drop at the channel inlet and for various riser lengths. The results are presented in a dimensional form, which is available, in first approximation, for all geometric scales and for all fluids. It was observed that the wall (nature and thickness) can be an important factor and that oscillation can occur in horizontal channels. (auth)

13952 (CEA-R-3014) DETERMINATION DU SPECTRE DE NEUTRONS DANS UN COEUR DE PILE A EAU. (Approximate Method for Solving the Velocity Dependent Transport Equation in a Slab Lattice). Ferrari, Achille (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 1966. 36p. (In French). Dep. mn.

A method is described that is intended to provide an approximate solution of the transport equation in a medium simulating a water-moderated plate filled reactor core. This medium is constituted by a periodic array of water channels and absorbing plates. The velocity dependent transport equation in slab geometry is included. The computation is performed in a water channel; the absorbing plates are accounted for by the boundary conditions. The scattering of neutrons in water is assumed isotropic, which allows the use of a double Pn approximation to deal with the angular dependence. (J.R.D.)

13953 (CEA-R-3026) ETUDE ET REALISATION D'UN ENSEMBLE DE CALCUL PUISSANCE–PERIODE POUR LE CONTROLE D'UN REACTEUR NUCLEAIRE. (Development of a Power–Period Calculation Unit for Nuclear Reactor Control). Martin, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 125p. (In French). Dep. mn.

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

The apparatus studied is a digital calculating assembly which makes it possible to prepare and to present numerically the period and power of a nuclear reactor during operation, from start-up to nominal power. The pulses from a fission chamber are analyzed continuously, using real time. A small number of elements is required because of the systematic use of a calculation technique comprising the determination of a base 2 logarithm by a linear approximation. The accuracy obtained for the period is of the

order of 14%; the response time of the order of the calculated period value. An approximate value of the power (30%) is given at each calculation cycle together with the power thresholds required for the control. (auth)

13954 (CEND-268) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF INDIAN POINT CORE B. Valerino, Michael F.; Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). June 8, 1966. Contract AT(38-1)-428. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of development of the ISOCHECK method to permit its direct application to the original core loading of Indian Point Reactor Core B are presented. The method calculates the ^{235}U depletion and total Pu content of normal batches of operating fuel elements in the reactor. Tables relating isotopic composition to accumulated exposure for each of the three fuel types constituting the original core loading are included. FLARE-code input physics parameters to permit direct use of the nuclear code for following the exposure history of the individual core assemblies, once the reactor operational data are obtained from the reactor operator and inputed into the code, are presented. A FLARE package was prepared for assumed reactor operating conditions in order to display the input and part of the output format of FLARE. Appendices are included on a standardized punched card input for FLARE and on modifications to the code to treat fuel switching and refueling. (H.D.R.)

13955 (CEND-268(Suppl.1)) INPUT CARD LISTING FOR SAMPLE FLARE PROBLEM USED IN THE SETUP OF THE ISOCHECK METHOD FOR INDIAN POINT CORE B. Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 28, 1966. Contract AT(38-1)-428. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

13956 (CEND-272) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF SAN ONOFRE CORE I. Valerino, Michael F.; Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). July 29, 1966. Contract AT(38-1)-428. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type present in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the original core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{235}U depletion and total Pu content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13957 (CEND-281) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF HUMBOLDT BAY CORE II. Valerino, Michael F.; Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 30, 1966. Contract AT(38-1)-428. 102p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type present in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the second core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{235}U depletion and total Pu content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13958 (CEND-282) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF NUCLEAR SHIP SAVANNAH CORE I. Kern, Richard; Shesler, Albert T.; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 6, 1966. Contract AT(38-1)-428. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type present in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the original core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{235}U depletion and total Pu content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13959 (CEND-285) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF SAXTON CORE II. Kern, Richard; Shesler, Albert T.; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Nov. 30, 1966. Contract AT(38-1)-428. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type presented in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the second core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{235}U depletion and total Pu content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13960 (CEND-286) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF ELK RIVER CORE II. Kern, Richard; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 12, 1966. Contract AT(38-1)-428. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type present in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the second core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{233}U, ^{235}U, and total fissile U content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13961 (CEND-287) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF CONNECTICUT YANKEE CORE I. Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 30, 1966. Contract AT(38-1)-428. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The calculations of the physics characteristics of each fuel type present in the reactor core over the range of neutron spectra encountered were performed using the FLARE code. Tables are presented relating isotopic composition to accumulated exposure for fuel assemblies constituting the original core loading. Application of the ISOCHECK method yields estimates of acceptable accuracy of the ^{235}U depletion and total Pu content for normal batches of operating fuel elements in the reactor. (H.D.R.)

13962 (CEND-283) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF PATHFINDER CORE I. Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 24, 1966. Contract AT(38-1)-428. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Specific application of the ISOCHECK method to Pathfinder Core I required a number of important simplifications of the reactor core composition. These simplifications are mainly due to differences in compositions of the upper and lower boiler regions of the core which could not be properly accounted for in the FLARE setup. In addition, the presence of shims, temporarily placed in the boiler region to meet the initial shutdown requirements, was ignored. Because of these and other simplifications, the degree of accuracy generally characteristic of the state of the art of reactor physics for water reactors (±5% for ^{235}U depletion and ±8% for total Pu content), cannot be expected of the analysis results for Pathfinder Core I. Instead, the anticipated accuracies are of the order ±8% for ^{235}U depletion and ±12% for the total Pu content. These accuracies apply for normal batches of boiler assemblies, which may consist of 20 or more assemblies, and for the entire loading of superheater assemblies. The batch is the smallest unit of interest, insofar as isotopic content for fuel accounting purposes is concerned, because fuel reprocessing occurs in batch loads. Inasmuch as the entire core load of superheater assemblies will be discharged at one time, the entire superheater fuel load is the batch of interest for reprocessing. (auth)

13963 (CONF-650105-9) DESIGN FEATURES OF THE CONNECTICUT YANKEE ATOMIC POWER PLANT. Paper No. CP 65-241. Vandenburgh, D. E. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Contract AT(30-1)-3250. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

The mechanical and electrical design of the Connecticut Yankee Atomic Power Plant is discussed. Design status, site, reactor plant, turbine-generator plant, and operational considerations are described. (M.C.G.)

13964 (EUR-2960.d) ABSCHIRMUNGSEXPERIMENTE AM FORSCHUNGSREAKTOR GEESTHACHT. JAHRESBERICHT 1965. (Shielding Experiments at the Reactor Station Geesthacht. Annual Report 1965). Bagge, E.; Fischer, E. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1966. 220p. Dep. mn.

The shielding experiments begun under the agreement between

EURATOM and Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH (GKSS) were continued in 1965. The experimental facilities ESTAKOS, ESTAGROP I, and the large irradiation channel in the FRG with the ESTAGROP II facility, were available for these studies. A research group developed and tested part of the measuring equipment and apparatus used in the experiments, and worked on the further development of neutron- and gamma-spectra measurement techniques. Work was continued on the calculation of the efficiency of shielding devices. (auth)

13965 (EUR–3111.i) SIMULAZIONE ANALOGICA DI UN IMPIANTO NUCLEARE AD ACQUA IN PRESSIONE PER PROPULSIONE NAVALE. (Analog Simulation of a Pressurized Water Nuclear Power Plant for Ship Propulsion). Dellacasa, G. (FIAT, Turin (Italy). Sezione Energia Nucleare); Jacovoni, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 232p. (In Italian). Dep. mn.

The plant, as simulated on the analog computer, is the nuclear power plant for ship propulsion. The detailed technical data are presented in the final report (Progetto Intermedio, June 1965–EUR 2629. i). Pressure and temperature transients of the nuclear power plant were analyzed under the most severe maneuvering conditions of the ship. The power control system operation and actuation of the safety systems were analyzed to prevent spurious scrams and to ensure the core thermal limits and plant mechanical limits. The instantaneous loss of load, the B loss, and the full power control rod withdrawal were investigated. (auth)

13966 (EUR–3112.i) SIMULAZIONE ANALOGICA DI UN IMPIANTO NUCLEARE AD ACQUA IN PRESSIONE CONTENENTE LE EQUAZIONI SPAZIO-TEMPORALI DEL NOCCIOLO. (Analog Simulation of a Pressurized Water Nuclear Power Plant With the Space-Time Core Equations). Bona, C. (European Atomic Energy Community); Jacovoni, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy); Pozzi, G. P. (FIAT, Turin (Italy). Sezione Energia Nucleare). 1966. 174p. (In Italian). Dep. mn.

The plant, as simulated on the analog computer, is a nuclear power plant for ship propulsion. The detailed technical data are presented in the final report (Progetto Intermedio, June 1965–EUR 2629.i). The core was subdivided into several cells; on each cell the neutron kinetics equations with one delayed neutron group coupled with the thermohydraulic equations were applied. These equations were correlated with others describing the plant including the steam generators. Transients such as load changes in turbine and full power control rod withdrawal were investigated. (auth)

13967 (EUR–3115.i) CENTRALE ELETTRONUCLEARE DI LATINA RELAZIONE ANNUALE 1965. (Latina Electronuclear Plant Annual Report of 1965). (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1966. 58p. (In Italian). Dep. mn.

The experience acquired during the second year of operation is reported with emphasis on the plant availability and the fuel behavior. The total production data for the years 1963, 1964, and 1965, including the monthly and mean factors of availability, of non-availability, and utilization for 1965 are given. The general criteria for the maintenance program, developed in the period May–June 1965 are given. Principal maintenance operations and a series of statistical data on personnel and time are listed. The principal data concerning the fuel cycle, the absorber cycle, and other operations are indicated. The chemical control of the primary coolant, the conditioning of the boilers, and the treatment of the active wastes are treated separately. The list of principal operations for the radiological protection of personnel is given and the statistical data on the doses received by personnel in 1965 are reported. The monthly graphs of the thermal power, the electric power, and position of the sector and general bars of the "B" groups are given. (tr-auth)

13968 (EUR–3159.e) EXPERIMENTAL STUDY OF THE STRESS DISTRIBUTION IN THE ESSOR REACTOR VESSEL WALL. Weltevreden, P. S.; Blanckenburg, J. F. G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 32p. Dep. mn.

The ESSOR reactor vessel contains a structural discontinuity in its cylindrical part. This discontinuity will give rise to local stress concentration in the membrane stress-field. Safety considerations require a determination of the amount of stress concentration to be expected and to give specifications for the construction of the vessel. A description is presented of the experimental stress analysis of this discontinuity-stress problem. Its primary scope is to demonstrate, by means of a practical example, the usefulness of the experimental stress analysis techniques regarding safe and economic design of important constructions. A review of the various existing techniques and their characteristics is included. (auth)

13969 (GA–6245) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Quarter Ending March 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 23, 1965. Contract AT(04-3)-187. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The feasibility study on the use of the Experimental Beryllium Oxide Reactor (EBOR) incorporating a Pu fueled core to demonstrate the Phoenix effect was completed. It was concluded from this study, primarily because of the heat removal limitations of the EBOR loop and secondarily because the principal objective must be the demonstration of most or all of the technical advantages purported for this fuel, that the only logical way to proceed is to use the semihomogeneous type of element being developed. Work continued on the development of methods for analytically determining the effective ^{240}Pu cross section in heterogeneous arrays. Also, the work on ^{6}Li diffusion continued, with the effort being concentrated on the possible retention of the ^{6}Li by graphite in the advanced fuel elements. In the basic materials area, work continued to be concentrated on the investigation of various techniques for fabricating oxide fuel in BeO. Samples were prepared for a single-section sweep capsule. This capsule was fabricated and inserted into the Materials Testing Reactor. On the test module for EBOR investigations, work was performed on a preliminary stress analysis of a SiC coated sleeve for the semihomogeneous type of element. In addition, some of the basic materials properties of both SiC and SiC coated graphite were determined. (auth)

13970 (GA–7126) THE IMPORTANCE OF THE APPROACH TO EQUILIBRIUM AND A COMPARISON OF ACCURATE REACTOR HISTORIES WITH EQUILIBRIUM FUEL CYCLES IN THE HTGR. Jaye, S.; Lee, D. H. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 26, 1966. Contract AT(04-3)-167. 17p. (CONF-660524–27). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

Large fuel cycle cost penalties, which are not reflected in the analysis of the equilibrium fuel cycle, can be incurred due to the initial operation of a reactor. By employing a strategy which takes advantage of the lack of fission product poisons in the first core, this penalty can be held to about 7% of the total fuel cycle cost in 1000 MW(e) HTGR's, using the cost parameters anticipated for the late 1970's or early 1980's. The penalty does not seem to be sensitive to the particular strategy employed, however, and the strategy can be chosen to yield operating conditions which are less severe than those expected at equilibrium. This could be of particular advantage when using newly designed fuel elements or primary system components. Equilibrium fuel cycle analyses can be used to define the optimum mode of operation, which is a considerable advantage due to their simplicity and low cost. This is particularly true when the effects of several reactor variables and economic parameters are to be considered. However, it must be recognized that even with a good strategy, a startup penalty of about 10% has to be added to the equilibrium costs. (auth)

13971 (GAMD–7351) PEACH BOTTOM, INITIAL LOADING TO CRITICALITY: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURE BP-1. Brown, J. R.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The loading of fuel into the Peach Bottom reactor began on February 5, 1966 with the placement of the first fuel element into the core. Loading was continued until a critical configuration was achieved with 682 fuel elements loaded on March 3, 1966. The predicted critical loading was 689 ± 20 elements. The approach to critical was monitored by performing inverse multiplication measurements at various stages during the loading sequence. The method of loading used was designed so that measurements during the subsequent low-power physics program would reflect as closely as possible the properties of the operating reactor. The location of detectors at the core-reflector interface with a source at the center of the core gave a very satisfactory approach to critical curve. The measured curve closely followed the predicted curve. The predicted and measured critical fuel element loading and critical mass were in close agreement. The reactivity of the just critical core agreed within 0.007 $\Delta\rho$ with the measured reactivity being greater. Since the calculations employed the most reactive thorium data, it appears that this data may be more appropriate than the Harwell 34 thorium data. The calculations neglected some possible negative reactivity effects such as neutron streaming and impurities. Inclusion of these effects could increase the discrepancy between the measured and calculated reactivity by as much as 0.010 $\Delta\rho$. It therefore appears that the U-235

data employed or some other effect may be producing too low a calculated reactivity. (auth)

13972 (GAMD-7352) PULSED SOURCE MEASUREMENTS OF CONTROL ROD WORTH IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURES BP-4, 6, 9, 13. Brown, J. R.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An extensive series of pulsed neutron measurements was performed during the low power testing program of the Peach Bottom HTGR for the purpose of determining the reactivity worth of various control rod patterns and the degree to which the fully loaded core was subcritical with the 36 control rods inserted. Pulsed neutron measurements were performed in both a core with a minimum amount of excess reactivity (683 fuel elements) and the fully-loaded core (804 fuel elements). The measurements in the 683 fuel element core yielded worths of control rods for configurations which will be encountered during power operation as well as a measurement of the reactivity worth of the entire bank of 36 control rods. This measurement, along with the measurement of the unrodded reactivity of the fully loaded core which was performed in the 683 element core, produced an early estimate of the shutdown margin to be expected in the fully loaded, fully rodded core. In general the pulsed neutron measurements in the Peach Bottom reactor yielded very close agreement between predicted and measured control rod worths. Approximately 25 different core configurations were pulsed, having reactivities as large as 40$ subcritical and 3 or more detector positions were used for each configuration. (J.M.J.)

13973 (GEAP-4900) REACTOR CONTROL SYSTEMS BASED ON COUNTING AND CAMPBELLING TECHNIQUES. FULL-RANGE INSTRUMENTATION DEVELOPMENT PROGRAM. Final Progress Report. DuBridge, R. A.; Neissel, J. P.; Boyd, L. R.; Green, W. K.; Pielage, H. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1965. Contract AT(04-3)-189. 196p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The analytical predictions and experimental results of a nuclear instrumentation development program to determine the feasibility of covering the complete reactor neutron flux range from 1×10^3 to 5×10^{13} nv in-core by using in-core or out-of-core ion chambers are described. A full-range reactor control instrumentation system consisting of two electronics subsystems was developed. Counting techniques are utilized for source and lower intermediate range neutron fluxes, and Campbell (or mean-square voltage) techniques are utilized for intermediate and power range fluxes. The development problems associated with the in-core counting detector, the in-core Campbelling detector, the in-core transmission lines, and the two-channel, full-range instrumentation system are presented. (H.D.R.)

13974 (GEAP-5086) PRESTRESSED CONCRETE PRESSURE VESSELS FOR BOILING WATER REACTORS. Quarterly Report No. 2, October-December 1965. Boggio, G. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Jan. 1966. Contract AT(04-3)-189. 83p. (EURAEC-1587). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

For the adaption of boiling water reactor (BWR) systems to service with a prestressed concrete pressure vessel, a number of arrangements of natural and forced circulation BWR systems in both spherical and cylindrical vessels were investigated. Cost and performance data are being accumulated for the selection of the most promising concept. The results obtained in the reporting period are presented with particular regard to vessel dimensions variation as function of reactor concept, power density, and vessel shape, core thermal-hydraulic performance for steady and dynamic states, coolant recirculation systems, and effect of reactor design pressure. Research and development work performed on vessel thermal insulation is presented by describing the insulation materials and systems under consideration, the experimental equipment constructed to test the material properties, the insulation installation techniques, and the transpiration cooling system flow distribution. (auth)

13975 (GEAP-5129) PRESSURE DROP AND DYE TESTS WITH WATER ON THE SEFOR PROTOTYPE FUEL BUNDLE. Williams, R. F.; Polomik, E. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1966. Contract AT(04-3)-540. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pressure drop, orifice calibration, bellows seal leakage, and flow visualization tests were performed with water, using a SEFOR prototype fuel bundle. The data cover the Reynolds number range of 5,000 to 70,000, based on the fuel bundle hydraulic diameter in the core region. A Reynolds number of 44,000 corresponds to flow in a central channel at 100% reactor flow. The data obtained with water were used to predict the pressure drop in sodium at reactor design flow rates and temperatures. The water data predicted 3.81 psi for a bundle with a 1.20-inch flowmeter at its inlet, with rated flow at 44,000 Reynolds number. For comparison, the mean measurement obtained with sodium under another test was 3.60 psi. The fuel bundle pressure drop, calculated from the mean curves for each component, agreed with the total measurement within 3%. Dye injection tests showed that flow channeled in the various flow regions formed by the channels and rods. It was estimated from these observations that circulation between flow regions was 5 to 10%. Leakage past the bellows seal, located between the bottom of the fuel channel and the grid plate, was found to be 0.1% or less of the fuel assembly flow. Flow in the central tightener sleeve area was estimated, from friction factor data, to be 7.6% of the total flow. This compares to 9.8% of the total flow if it were distributed to the ratio of the flow areas. (auth)

13976 (GEAP-5151) PRESTRESSED CONCRETE PRESSURE VESSELS FOR BOILING WATER REACTORS. Third Quarterly Report, January-March 1966. Boggio, G. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Apr. 1966. Contract AT(04-3)-189. 68p. (EURAEC-1636). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed Under United States-Euratom Joint Research and Development Program.

The conceptual design study performed to select the most suitable boiling-water reactor (BWR) system for service with a prestressed concrete pressure vessel was completed and its results are summarized. Results of thermal-hydraulic calculations and cost evaluation are presented for the different reactor concepts taken into consideration. On the basis of both feasibility and economics, the system selected for the reference design study, Task II, is one employing free surface steam separation, with feedwater-driven jet pumps, installed in a cylindrical vessel. Work was started on the preparation of a reference design of the selected reactor concept; accomplishments to date are presented. Preliminary experimental results are reported on vessel thermal insulation materials. (auth)

13977 (GEAP-5289) HEAT TRANSFER IN SEVEN-ROD CLUSTERS. INFLUENCE OF LINER AND SPACER GEOMETRY ON SUPERHEAT FUEL PERFORMANCE. Hoffmann, H. J.; Miller, C. W.; Sozzi, G. L.; Sutherland, W. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1966. Contract AT(04-3)-189. 97p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The general problem of heat transfer in an array of seven rods is considered. Heat transfer, pressure drop, velocity, and temperature distribution measurements were made with air flow (Pr = 0.7) past electrically heated rods. Two liner geometries were investigated, circular and scalloped shaped, with rod center-to-center spacing to rod diameter ratios of 1.141 and 1.237. Rod alignment and spacing were maintained by small pin-type spacers, grid-type spacers, or wire-wrap spacers. The data obtained over a Reynolds number range of 5,000 to 150,000 provided the engineering information necessary for optimization of heat transfer performance in nuclear superheat fuel elements. (auth)

13978 (INR-723/IX/R) ZAGADNIENIA EKONOMICZNE CYKLI PALIWOWYCH. (Economic Aspects of Fuel Cycle). Kazimierski, T. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 35p. (In Polish). Dep.

The capital cost of nuclear power plants is high as compared with conventional plants. Thus, to be competitive, nuclear power plants must reduce fuel cycle costs. All steps of fuel cycle and their costs are discussed along with possible reductions in costs. (auth)

13979 (JUL-382-RG) ENTWICKLUNGSPROBLEME EINES HOCHTEMPERATUR-THORIUM-BRUTREAKTORS. (Development Problems of a High-Temperature Thorium Breeder Reactor). Hecker, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Sept. 1966. 28p. (In German). Dep. mn.

The principal problem in the further development of high temperature breeder reactors with short multiplication times consists in addition to the development of suitable methods for the covering of BeO, in making the processing and refabrication methods as simple and inexpensive as possible so that the fuel cycle in spite of the relatively small burnup of 20,000 to 30,000 MWd/t is still economic. The improvement of neutron economy of a high temperature reactor that can be obtained by the use of BeO as moderator was calculated. A method for the continuous processing of the spherical fuel elements of a pebble-bed high-temperature reactor is proposed. The decontamination stage proposed-diffusion and volatilization processes-is unconventional. A program for the testing and verification of the proposed method is outlined. (J.S.R.)

13980 (NP-16276) COMPARISON OF COAL-FIRED AND NUCLEAR POWER PLANTS FOR THE TVA SYSTEM. (Tennessee Valley Authority, Chattanooga, Office of Power). June 1966. 36p. TVA, Div. of Power Supply, Chattanooga, Tenn.

Nuclear reactors of the BWR and PWR types are compared with each other and with coal-fired plants for power production. The comparisons are made on the basis of total cost and energy delivered. The economic evaluations include plant investment, fuel, plant operation and maintenance, transmission investment, operation, nuclear insurance, losses, and other direct costs. (J.R.D.)

13981 (NP-16364) POWER REACTOR CHARACTERISTICS. Report No. 1. (Organization for Economic Co-operation and Development, Paris (France). European Nuclear Energy Agency, Paris (France)). Sept. 1966. 84p. Dep. mn.

Information concerning the basic parameters of various reactor types are presented to facilitate future studies involving simultaneous consideration of several types. Data and information are included on graphite-moderated, gas-cooled reactors, light water reactors, heavy water reactors, fast reactors, liquid fuel reactors, and calculation of U requirements. (J.R.D.)

13982 (ORNL-3970, pp 141-5) BONUS FUEL ELEMENT DEVELOPMENT. Slaughter, G. M.; Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

A 32-rod BONUS fuel assembly was successfully rebuilt using manufacturing procedures that provided significant improvements over those used by the manufacturer of the original core loading. Technical assistance was given to ORGDP concerning the fabrication of eight advanced fuel assemblies to be fabricated for the BONUS Reactor. It was decided to use Incoloy 800 as the fuel cladding material for these assemblies, primarily because it resists corrosion by superheated steam better than the Inconel 600 used for core I. Mechanical properties studies have concentrated on the collapse behavior of fuel tubes made from alloys being considered for advanced BONUS applications. Nondestructive testing studies are being conducted to develop improved techniques for testing the fuel elements. The problem areas include evaluation of the fuel cladding, the spacer-to-cladding braze bonds, and the welds in the fuel, coolant, and pressure tubes. Brazing studies on Incoloy-800 tubing have shown the influence of temperature and time upon grain growth of material in the annealed and cold-worked conditions. (auth)

13983 (ORNL-4033) EFFECTS OF CONTAINMENT SYSTEM SIZE ON FISSION PRODUCT BEHAVIOR. Watson, G. M.; Perez, R. B.; Fontana, M. H. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Some simple mathematical models were formulated for very rough predictions of the effect of containment size and other experimental variables on the plate-out behavior of iodine. Two classes of systems were considered depending on the absence or presence of steam and many simplifying assumptions were introduced. The mathematical expressions were correlated with experimental data from iodine-air and iodine-steam experiments in the Containment Mockup Facility, Containment Research Installation, and Nuclear Safety Pilot Plant with moderate success. (H.D.R.)

13984 (PRWRA-103) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 8. (Puerto Rico Water Resources Authority, San Juan). Aug. 1966. Contract AT(40-1)-2672. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information is included on operating experience, measurements and tests, maintenance, operating procedures, and transient analyses. (J.R.D.)

13985 (RISO-M-462) KORTFATTET OVERSIGT OVER AUTOMATISERING AF NUKLEARE KRAFTVAERKER. (Automatic Instrumentation for Nuclear Power Plant). Pederson, O. M. (Danish Atomic Energy Commission, Risoe, Research Establishment). Sept. 1966. 8p. (In Danish). Dep. mn.

The instrumentation and automation of nuclear power stations, existing and planned are reviewed. Experience and trends are emphasized including trends of conventional power plants. (auth)

13986 (RT-FIMA-(66)-4) SCR: PROGRAMMA IBM-7094 PER IL CALCOLO DI TRANSITORI RAPIDI DI POTENZA DI REATTORI NUCLEARI. (SCR: An IBM-7094 Code for the Calculation of Nuclear Reactor Fast Power Transients). Casadei, G.; Fucci, C.; Leproni, V.; Papa, G.; Scafe, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 33p. (In Italian). Dep. mn.

The SCR code may be used to calculate fast power transients, owing to accidents in water moderated reactors with plate-type fuel elements, not considering the reactor safety system. The kinetic equations solved are space-independent, with one energy group and N groups of delayed neutrons. The accidents are simulated by step and ramp (linear or parabolic) reactivity insertions. The reactivity feedback terms are dependent on metal and water temperature variations and void formation due to radiolytic gases and water boiling. The set of differential equations is solved by the use of numerical integration formulas of the Runge-Kutta type. (auth)

13987 (STL-372-44) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending June 30, 1966. Firstenberg, A. F.; Neal, L. G.; Wentz, L. B.; Zivi, S. M. (TRW Systems, Redondo Beach, Calif. Applied Thermodynamics Dept.). July 31, 1966. Contract AT(04-3)-372. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The possibility that oxide fueled power reactor melting accidents arising from loss of flow, a blocked channel, or a very rapid large reactivity insertion could produce in-core pressures that might disable engineered safeguards or rupture primary coolant systems is considered. It was found that destructive pressures could occur in such reactors similar to the pressures produced in SPERT-ID, SL-1, and BORAX-I by the dispersal of the molten Al-UO_2 fuel into the core water. The approach to instability in 100 MW operation of the Experimental Boiling Water Reactor is analyzed using the hydrodynamics of the STABLE-3 model of hydrodynamic instability. It was found that the instability is caused by power-void reactivity feedback augmented by hydrodynamic resonance between the plate-type and rod-bundle fuel assemblies. Final results on an analysis of distributional effects in two-phase flow are presented. A two-phase flow model of an annular flow regime was developed on the basis of this analysis and applied to experimental data from other investigations with considerable accuracy. (H.D.R.)

13988 (STL-372-47) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending September 30, 1966. Firstenberg, A. F.; Humberstone, G. H.; Neal, L. G.; Wentz, L. B. (TRW Systems, Redondo Beach, Calif. Applied Thermodynamics Dept.). Oct. 31, 1966. Contract AT(04-3)-372. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The pressure pulse produced by water impact on molten Al, molten Ag, and hot powdered UO_2 was measured in shock tube experiments. Very high pressure pulses were produced by the molten Al and Ag and low pressures were produced by the hot UO_2. The effects of initial pressures up to 1500 psia in the in-pile capsule experiment on rapid transient steam-void growth and collapse are presented. Power-void transfer functions and steam-void distributions in subcooled boiling at 300 and 700 psia were measured and analyzed. (H.D.R.)

13989 (TID-8200(15th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1966. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information is included on reactors categorized by their use. The categories are civilian, military, production, and export. Critical assembly facilities are also listed. (J.R.D.)

13990 (TID-23658) 237 MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 12, January 1-March 31, 1966. (Kernkraftwerk RWE-Bayerwerk G.m.b.H., Gundremmingen (West Germany)). 104p. (KRB-1966/1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Since the beginning of the year the main work carried out on the site has been devoted to commissioning and preliminary tests rather than assembly and construction. The hydrostatic tests were carried out on the primary circuit locks and leaktightness tests on the condenser and locks. The primary and secondary steam lines were blown out. Flushing and cleaning work was continued in all the circuits. With the exception of the off-gas line and a few tests which still have to be performed, the pre-operational trials of the conventional part of the plant are now finished. The large majority of the nuclear systems have also undergone preliminary trials. (auth)

13991 (WAPD-TM-639) THERMAL FEEDBACK CALCULATIONS IN THE PDQ-5 FEW-GROUP NEUTRON DIFFUSION-DEPLETION COMPUTER PROGRAM. Sorensen, J. N. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

PDQ-5 is a digital computer program for the solution of the few-group neutron diffusion-depletion problem in one or two space dimensions. The thermal calculations necessary to incorporate temperature feedback into the r-Z geometry option of PDQ-5 are described. The problem investigated is obtaining the fuel temperature, moderator temperature, and moderator density when the core power distribution is known. (auth)

13992 (WCAP-3269-58) REACTOR FOULING EXPERIMENT. Picone, L. F.; Taylor, G. R.; Impink, A. J.; Rajagopal, V. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). July 1966. Contract AT(30-1)-3269. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An experiment was conducted to investigate a reactor procedure for determining the presence of boron concentration on in-core surfaces. The out-of-pile test development work as well as the reactor experiment itself is presented. (auth)

13993 (JPRS-38717) COOLANTS FOR NUCLEAR POWER ENGINEERING INSTALLATIONS. Ulybin, Sergey Arkhipovich. Translation of Teplonositeli Energeticheskikh Yadernykh Ustanovok, Energiya, Moscow-Leningrad, 1966. 308p. (TT-66-35141). CFSTI $3.00 cy, $0.65 mn.

Radiation effects on coolants and radioinduced corrosion of structural materials are described. Methods of calculating coolant radioactivity are discussed. Data and information concerning the thermophysical, corrosive, and other properties of water, organic liquids, liquid metal, and gas coolants are included. Construction and operation of reactors as determined by the coolant used are discussed. (J.R.D.)

13994 THEORY OF THE DIFFUSION OF NUCLEAR REACTORS. De Azcarraga, Jose Adolfo (Univ., Barcelona). Dyna, No. 12, 639-48(Dec. 1965). (In Spanish).

Neutron scattering and the operational conditions of homogeneous thermal reactors are analyzed. The scattering equation is calculated using a series of simplifying hypotheses and the Fermi age theory. The critical equations are obtained and the effect of the factors affecting them is discussed. (tr-auth)

13995 DERIVATION OF THE KINETIC EQUATIONS OF A NUCLEAR REACTOR DEDUCED FROM THE BOLTZMANN EQUATION. Tarrasa, R. Gonzalez (Univ. Central de Venezuela, Caracas). Acta Cient. Venezol., 16: 219-24(1965). (In Spanish).

A neutron transport equation is developed from the conversation requirements between the neutrons produced by fission and those lost by absorption and leakage. The equation depends on seven variables; for simple problems, one, two, or three variables are found, and for very complex problems all seven appear, so that the equation may be solved only by statistics. For most problem the complexity falls between these extremes. Production and destruction operators appear in the equation; an importance function is defined, together with concepts such as those for the effective values of neutron population and delayed neutron precursors, effectiveness of delayed neutrons, neutron lifetime, and criticality factor of the reactor. From these devices the kinetic equations are deduced from the Boltzmann equation; the kinetic equations depend on only one variable and are adaptable to everyday use. (BBB)

13996 SWEDEN'S NUCLEAR ENERGY WORK: OBJECTIVES, ORGANIZATION, AND RESOURCES. Sandstroem, Sten (Aktiebolaget Atomenergi, Stockholm). Energ. Nucl. (Milan), 13: 497-504(Sept. 1966). (In Italian).

Sweden is one of the more advanced countries in the development of the industrial applications of nuclear energy. A short historical account is given on the basic steps which marked such development in Sweden, and a report is included on the nuclear power program, resources, national organization and cooperation, and the industrial capacities of the country to supply internal needs and possible foreign requests. (auth)

13997 APPROXIMATE DESCRIPTION OF THE KINETICS OF A REACTOR DURING STABILITY INVESTIGATIONS. Mitenkov, F. M.; Boyarinov, V. S. At. Energ. (USSR), 21: 293-4(Oct. 1966). (In Russian).

The stability characteristics of reactors can be obtained by replacing the six groups of delayed neutrons in the kinetic equations by one or two equivalent groups, whose parameters are chosen to approximate the variation of the neutron density within the same time interval. The corresponding equations for the parameters of the equivalent groups and a comparison of the limits of the stability regions for different numbers of equivalent groups and for different parameters are contained. The calculations were made for very simple reactor models with automatic control and for self-regulating reactors. It is shown that the best choice of the parameters of the equivalent groups should minimize the deviation of the corresponding points of the amplitude-phase characteristics. If this is done, the calculated limits of the stability regions will be quite close to the limits calculated with six groups of delayed neutrons, even if a single equivalent group is used. (ATD)

13998 INFLUENCE OF STRUCTURAL MATERIAL ON ACTIVITY OF DEPOSITION CORROSION PRODUCTS. Veselkin, A. P.; Shakh, O. Ya. At. Energ. (USSR), 21: 462-5(Dec. 1966). (In Russian).

Radiation protection problems related to corrosion and activation of reactor construction materials are discussed. The influence of the surface material of the primary circuit on the formation of active surface deposits is analyzed using a mathematical model. Problems on wash-off, transfer, and deposit of materials are computed. Correlated theoretical and experimental data are in good agreement. In order to improve radiation hazard conditions during repairs steel without long-lived isotopes is recommended. For example, activated chrome–manganese steel possess a short half-life period (manganese) and small γ-quantum yield per decay (chromium). (R.V.J.)

13999 DISTRIBUTION OF CORROSION OF CONSTRUCTION MATERIALS AND NEUTRON IRRADIATION. Tskhvirashvili, D. G.; Vasadze, L. E.; Tsukh, A. S. At. Energ. (USSR), 21: 300-2(Oct. 1966). (In Russian).

Design and operation of Nuclear Power Plants with boiling water reactors demand detailed data on the migration of corrosion products dissolved in water into the vapor. Presently, data are available on the distribution of cobalt and iron oxides between the water and vapor in the absence of irradiation. An attempt was made to determine the regularities in distribution of corrosion products of aluminum and stainless steel from devices installed in a reactor coolant channel and irradiated with neutrons at 78 to 176 bar pressure. For Al, water activity was determined by the reaction $^{27}Al(n,\alpha)^{27}Na$ by measuring the half-life and γ-energy in water specimens. The distribution coefficients for ^{27}Na were in agreement with the data on distribution coefficients of unirradiated NaOH. For the carbon steel, the water activity was determined by ^{58}Co and to a lesser degree by ^{59}Fe. The coefficients of distribution of natural corrosion products were in agreement with the coefficients obtained for the monosolutions. In boiling water reactors the main contributors are Co, Fe, Cr, and stainless steel, and carbon steel corrosion products which are mainly iron oxides. It was necessary to determine also the distribution coefficients for the corrosion products of austenite stainless and pearlite steels. The results showed that the migration of corrosion products into the steam is considerable not only at super high pressures but even at mean pressures. The neutron flux does not effect them, thus the data obtained with unirradiated materials may be used for boiling water reactors. (R.V.J.)

14000 MEASUREMENTS OF VOID EFFECTS ON THE REACTIVITY. Chrysochoides, N. G. (Democritus Nuclear Research Center, Athens). Chim. Chron. (Athens, Greece), 30A: 137-42 (1965).

Two experimental methods were used to simulate voids in the reactor moderator: (a) Statical method, in which air gaps were introduced in the reactor moderator, (b) dynamic method, in which steam bubbles were created in the reactor moderator. The effects of the voids on the reactor reactivity were measured and the void coefficients were evaluated. The first method, which simulates better the case of uniformly distributed air in the moderator, gives accurate results. The proposed second method, which simulates better the case of real steam bubble formation in the moderator, is simple and gives satisfactory results for fair approximation. (auth)

14001 A NUCLEAR POWER PROGRAM FOR THE SWISS. Kobusch, Bert. Glueckauf, 102: 544-7(1966). (In German).

The future power requirements of Swiss industry are briefly summarized and the economic conditions favorable for the introduction of nuclear power plants are indicated. The reactor development policies of Euratom are summarized. (J.S.R.)

14002 NEW PROBLEMS FOR NUCLEAR ENERGY. Kobusch, Bert. Glueckauf, 101: 1364-8(1965). (In German).

The long term nuclear energy program of Euratom based on the energy needs is briefly reviewed. The results of the Foratom congress, which focused on the foreseeable production conditions, and the subsequent effects on the future utilization of nuclear power are discussed. (J.S.R.)

14003 FREQUENCY AND SPECTRAL ANALYSIS OF CHARACTERISTIC TEMPERATURES IN REACTOR CHANNEL. Feretic, D.; Sultan, M. A. (Atomic Energy Establishment, Inshas, Egypt). Atomkernenergie, 11: 441-5(1966).

An analytical solution for determining the dynamics of reactor channel based on the consideration of a distributed parameter system is presented. Frequency response data are obtained for three characteristic temperatures in the reactor channel namely, the coolant, the fuel surface, and the axial fuel temperatures. These frequency response data are used for the analysis of stochastic processes in the reactor channel by applying the linear spectral techniques. (auth)

14004 APPLICATION TO THE NUCLEAR FIELD OF NEW METHODS OF THE THEORY OF AUTOMATIC CONTROL.

Rasetti, M. (Politecnico, Turin); Vallauri, M. Energ. Nucl. (Milan), 13: 668-79(Dec. 1966).

Variational formulations for use in development of optimal control strategies for nuclear plants are described. The fundamental concept of these methods is that of state variables. The basic steps of the methods are described and proof of the technique is presented. Use of the methods allows synthesis of control systems which exhibit optimum performance for a large range of input perturbations. The possibility of programming the operation of control systems designed using these methods is examined. (J.R.D.)

14005 HIGH-TEMPERATURE GAS-COOLED REACTOR AND GASTURBINE. Spillmann, W. Atomkernenergie, 11: 352-6(1966). (In German).

The gas turbine projects and study work for the OECD-Dragon reactor are summarized. A prototype compact power plant (ML-1 of AEC and US Army) has given first practical experience and a number of papers collected the information on this development work. A number of small power conversion-units are under development and many special applications (space-propulsion) are considered. For power stations a complete proposal for a German (GHH) 22 MWe plant with a direct He-cycle is supposed to be in the final development stages. A review of nuclear-closed-cycle gas turbine-systems is included. (J.R.D.)

14006 HIGH TEMPERATURE REACTORS WITH GAS TURBINES. Boehm, E. (Kernenergieabteilung der Gutehoffnungshuette, Oberhausen, Ger.). Atomkernenergie, 11: 343-52(1966).

By combining a high-temperature reactor and a gas turbine, the advantage of high-temperature operation can be fully utilized at higher temperature levels. In the past few years GHH has been engaged in several studies on the combination of gas-cooled high-temperature reactors and gas turbines. The main object of these studies was to develop heat-and-power plants of this type and marine propulsion units. At present GHH is carrying out project work for a 20 MWe closed-cycle gas turbine prototype plant utilizing a He-cooled high-temperature reactor with prismatic fuel elements. Construction work could be started in the spring of 1967. The prototype plant is described and aspects are considered which arise by combining a gas turbine and a high temperature reactor. (auth)

14007 EXISTENCE OF SEMI-EIGENVECTORS AND CRITICALITY IN A REACTOR. Bakhtin, I. A. Sibirsk. Mat. Zh., 6: No. 5, 949-57[1966]. (In Russian).

Existence theorems are proved for the solutions of the system $x = \mu A(x,y)$, $y = B(x,y)$, and these results are applied to the study of criticality in a nuclear reactor. The equations are rewritten in the form $z = C(\mu)z$ and a solution $z = (x,y)$ is called a semi-eigenvector of the operator C if $x \neq 0$. The existence of such vector solutions is proved under various assumptions for continuous operators C. The theorems are used to prove that, for the set of integral equations describing the neutron distribution and temperature regime in a reactor, the operator semi-eigenvectors form a conditionally continuous branch infinite in length. (ATD)

14008 INVERSION SOLUTION OF EQUATIONS OF REACTOR KINETICS. Brikker, I. N. At. Energ. (USSR), 21: 9-13(July 1966). (In Russian).

From nuclear reactor kinetic equations, functions were found for determining the variations of the breeding coefficient when the changes in the neutron density are known. The functions were also used to find a law with which the breeding coefficients can be varied in order that the variation of the neutron density be feasible with the law assigned. (tr-auth)

14009 STABILITY OF NUCLEAR POWER PLANT WITH CIRCULATING FUEL. Goryachenko, V. D. At. Energy. (USSR), 21: 3-6(July 1966). (In Russian).

A nuclear power plant with circulating incompressible fuel was examined. The active zone of the reactor was an idealized system with centered parameters and the heat exchangers had links of separated parameters. The stability in the narrow stationary regime of reactor operation was shown. For exceptional cases when the rate of delayed neutrons is negligible, the stability with respect to arbitrary deviation from equilibrium conditions was shown. (tr-auth)

14010 METHOD OF SOLUTION OF DIFFUSION EQUATION. Shulepin, V. S. At. Energ. (USSR), 21: 209-10(Sept. 1966). (In Russian).

An analysis was made to show that the homogeneous equation for neutron flux in a symmetric one-dimensional reactor can be reduced to a factorized two-nonlinear equations of the first order. (R.V.J.)

14011 ASEISMIC DESIGN OF REACTOR ENCLOSURE OF THE JAPAN POWER DEMONSTRATION REACTOR (JPDR) AND ITS ACTUAL BEHAVIOR FOR EARTHQUAKE. Tajimi, Hiroshi (Nihon Univ., Japan); Ichino, Ichiro. Bull. JSME (Jap. Soc. Mech. Eng.), 9: 294-9(May 1966).

Being situated in a frequent seismic area, aseismic design analysis of nuclear reactors to be constructed in this country is required for safety. For the JPDR the vibration characteristics of reactor containment structure, for factors such as natural period and damping acceleration were analyzed to check the validity of static design earthquake coefficient. After completion of the plant, many seismic sensors were mounted on various parts of the enclosure structure to observe its vibration characteristics during earthquake. Using the data obtained from an actual earthquake, the natural period, location of rocking centers, etc., were calculated. The calculated values show good agreement with the above mentioned analytical results. (NSA of Japan)

14012 CONSTRUCTION PLAN OF TSURUGA ATOMIC POWER STATION. Yoshioka, Toshio (Japan Atomic Power Co.). Genshiryoku Kogyo, 12: No. 2, 5-9(Feb. 1966). (In Japanese).

Construction is planned for a power station at Tsuruga with a 1,000,000 kW power output. U. S. GE, the successful bidder in 1963, will supply boiling-water type reactors. The pressure vessel will be a steel cylindrical body. UO_2 pellets will be employed as fuel. (NSA of Japan)

14013 PLANNING OF THE CONSTRUCTION OF THE TSURUGA ATOMIC POWER STATION. Nomoto, Teruo (Japan Atomic Power Co.). Karyoku Hatsuden, 17: 522-9(June 1966). (In Japanese).

An atomic power station is planned on Tsuruga Peninsula. The power plant will be based on a 325 MW boiling-water type reactor. Construction will be started in March 1966 and completed by 1969. Descriptions concerning the planning are given on the course taken to the decision on the construction, selection of the site, site investigations carried out, civil-engineering works thus far finished, pre-investigations of possible power reactors, selection of the plant contractor, the specifications for the estimates by the maker, and plant and facilities to be constructed. (NSA of Japan)

14014 SOME GOVERNMENTAL PROBLEMS ON SAFETY IN NUCLEAR REACTOR FACILITIES IN JAPAN. Anzai, Ikuro (Tokyo Univ.). Nippon Koshu Eisei Zasshi, 13: 121-31(Mar. 1966).

In recent years the development rate of nuclear power for practical use has been greatly increased in Japan. More than a dozen research reactors and a power generating reactor are now in operation. It is often discussed, however, that, nuclear reactors have latent possibility of serious accidents involving with the release of radioactive substances. Main difficulties in this problem arise from insufficient amount of experience in operation and knowledge of radiation effects on human body. Governmental problems related to safety in nuclear reactor facilities in Japan are discussed. (auth)

14015 DYNAMIC LOAD OF THE CONTAINMENT SHELL IN THE COURSE OF A SEVERE REACTOR ACCIDENT. Seipel, H. G. Atomkernenergie, 11: 367-72(1966). (In German).

A rupture in the main coolant circuit of a large water-cooled power reactor causes a dynamic load of the containment shell. Usually, the vapor container of such a reactor is subdivided into many compartments. A rapid coolant discharge is followed by a complicated vapor flow pattern and large pressure differences between the compartments. Eventually, the walls between the compartments may be pushed aside. Concrete blocks, where piled up upon each other, may be lifted and propelled against the containment shell. In a pressure suppression system of the Humboldt Bay type, special problems arise. Exploding pipes have a missile effect and the jet of the escaping fluid is likely to strike the dry-well wall. Shock waves generated by a disrupture of the coolant pipe should be considered. Their peak pressure may exceed the design pressure of the vapor container. A simplified model may be used to evaluate the pulse pressure of a shock wave, that a spherical container will sustain and the parameters responsible for this value. (auth)

14016 INTERNAL STRUCTURE OF GRAPHITE-GAS REACTORS OF THE EDF-4 TYPE. Rachais, Claude. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 8-13(Sept.-Oct. 1966). (In French).

The internal structures include all the elements used for the support of the graphite constituting the reactor core. In the EDF-4 Reactor the integration of exchangers has added new problems. The problems inherent to the graphite stacking mechanics, problems posed by the integration of exchangers and particular problems from the change of the circulation direction of the heat-carrying gas are indicated. A brief description is

given of each of the constituent elements of the internal structure. The assembly specifications have imposed a simultaneous prefabrication of the site of the two large pieces that constitute the air-support and the skirt. (J.S.R.)

14017 PRESENT STATE OF WORK ON THE EL-4. Schulhof, Pierre (CEA, Paris); Dupuy, Jean-Charles. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 14-20(Sept.-Oct. 1966). (In French).

The changes made in the assembly and testing schedule of the EL-4 Reactor necessitated by the difficulties encountered in the welding of the vessel bottom are summarized. (J.S.R.)

14018 BUGEY I NUCLEAR POWER STATION. THE REACTOR VESSEL. Robert, M. E. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 21-3 (Sept.-Oct. 1966). (In French).

The BUGEY I Reactor design is based on the utilization of an annular fuel element cooled internally and externally. The characteristics of the reactor, the reactor geometry, and fuel element characteristics are compared with those of the EDF-4. The design of the reactor vessel is sketched and compared with that of the EDF-4. (J.S.R.)

14019 BUGEY I NUCLEAR POWER STATION. DEVELOPMENT OF THE DESIGN OF THE PRESTRESSED CONCRETE VESSEL. Launay, M. P. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 24-33(Sept.-Oct. 1966). (In French).

The hypotheses taken into consideration for the vessel calculation are outlined. The preliminary tests made on the upper tubular block are summarized. The behavior of the vessel in the elastic phase was theoretically studied, and the calculation data were experimentally verified by tests on the concrete and cables. The one-fifth scale tests made under thermal conditions and pressure cycling verified the calculations. (J.S.R.)

14020 NUCLEAR ENERGY. EVOLUTION OF NUCLEAR TECHNOLOGY. ABSTRACT OF THE REPORT ON THE ENERGY POLITICS OF THE COMITE DE L'ENERGIE DE L'ORGANIZATION DE COOPERATION ET DE DEVELOPPEMENT ECONOMIQUES (O.C.D.E.). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 63-8(Sept.-Oct. 1966). (In French).

The probable evolution of the costs of nuclear electrical energy is outlined and the increase of the nuclear production capacity is estimated. The needs and resources in natural uranium, enriched uranium, and plutonium are considered with respect to the nuclear costs and production capacity. (J.S.R.)

14021 FRENCH CARBON DIOXIDE BLOWERS FOR NUCLEAR REACTOR EQUIPMENT. Laurent, M.; Laferriere, P.; Chaboseau, J.; Servanty, P. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 45-52(Sept.-Oct. 1966). (In French).

The principal characteristics in the evolution of carbon dioxide blowers for nuclear reactors are outlined. The Marcoule, Chinon-3, Chinon-2 and Brennilis blowers are described. Axial blowers with adjustable rotary blades are also described. (J.S.R.)

14022 NUCLEAR ENERGY FOR UNDERWATER USES. Comit. Naz. Energ. Nucl., Notiz., 12: No. 8-9, 95-100(Aug.-Sept. 1966). (In Italian).

A review of the underwater uses of nuclear energy is presented in which the possible applications of nuclear reactors and radioisotopes are discussed. (auth)

14023 RADIOPROTECTION ORGANIZATION AT THE CHINON NUCLEAR POWER STATION. Bertron, M. L. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 56-62(Sept.-Oct. 1966). (In French).

The classical organization of a power station is outlined, and the principles of radioprotection in a nuclear power station are given. The details of the radioprotection at the Chinon power station are: surveillance around the installation, monitoring in the contaminated zone, specific radioprotection measures, access control and monitoring surveillance, and role of the power plant management. The principal difficulties encountered are outlined. (J.S.R.)

14024 A REVIEW OF PEBBLE BED REACTORS AND THE CHARACTERISTICS OF PACKED BEDS. Claxton, K. T. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy: Pt. A and B, 20: 735-77(Sept. 1966).

A general picture of the pebble bed reactor concept up to the present time is given. The main advantages and disadvantages are listed, these being chiefly concerned with the rather unique spherical fuel element. The principal performance and design data are given for an experimental pebble bed reactor and power plant as conceived by the Oak Ridge design team. Also included are data and a description of the BBC–Krupp reactor (AVR) of the pebble bed type under construction at Julich in West Germany. Mention is also made of a possible West German pebble bed power reactor (THTR). An account is given of the Australian work on pebble bed reactors which differs from all others in the choice of support material for the fuel. A more detailed account follows of three important aspects of this reactor type—fuel elements, coolant contamination, and fuel handling. This is followed by sections on the heat transfer and fluid dynamic characteristics of packed beds, of which the pebble bed reactor is an example. In conclusion some of the principal research and development problems associated with this reactor concept are discussed. An appendix summarizes the various pebble bed reactors conceived since the original conceptual design by Farrington Daniels in 1944. (auth)

14025 REACTOR SAFETY BY POSITIVE POWER COEFFICIENTS: THE REACTIVITY OF THE KNK AS AN EXAMPLE. Huebel, H.; Knecht, O.; Mausbeck, H. (INTERATOM GmbH, Bensberg, Ger.). Atomwirtschaft, 11: 506-10(Oct. 1966). (In German).

Using the Na-coaled KNK reactor as an example, it is shown that the usual safety requirements for thermal reactors can be fulfilled by positive power coefficients. Stability of uncontrolled reactors and control of nuclear excursions are discussed. (M.C.G.)

14026 PERTURBATION ESTIMATES FOR NUCLEAR REACTORS BY THE MONTE CARLO METHOD. Mikhailov, G. A. Zh. Vychisl. Mat. Mat. Fiz., 6: 380-4(Mar.-Apr. 1966). (In Russian).

The Monte Carlo method is used to apply the general formula for small perturbations to the problem of obtaining perturbation estimates for nuclear reactors. The necessary value function of the neutrons $f^*(x)$ is defined in phase space X with coordinates x and velocity v and satisfies the relation $kf^* = N^*f^*$, where k is the effective coefficient of propagation of the reactor, N is the neutron propagation operator for one generation. The quantities δk for a small perturbation in the reactor are computed by the Monte Carlo method. (ATD)

14027 FAST-NEUTRON SPECTRA IN WATER AND GRAPHITE. Harris, L. Jr.; Sherwood, G.; King, J. S. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 26: 571-3(Dec. 1966).

Measurements of space-dependent fast neutron spectra in water and graphite at 2.0 and 12.0 MeV for fluxes directed normally to the Ford reactor core face with penetrations up to 60 Cm are reported. Comparisons of the measurement values were made with those calculated using the shielding code NIOBE. A solid-state proton-recoil telescope was used to measure neutron energies. (J.R.D.)

14028 QUASISTATIC TREATMENT OF SPATIAL PHENOMENA IN REACTOR DYNAMICS. Ott, Karl (Argonne National Lab., Ill.). Nucl. Sci. Eng., 26: 563-4(Dec. 1966).

An improved quasistatic model for analysis of spatial phenomena related to control and dynamics of large reactors is proposed which should give reliable results in most cases. Aspects of the model related to prompt neutrons and delayed neutrons are discussed. (J.R.D.)

14029 REACTOR ORGANIC COOLANTS. I. CHARACTERISTICS OF IRRADIATED HYDROGENATED TERPHENYLS. Tomlinson, M.; Smee, J. L.; Winters, E. B.; Arneson, M. C. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Nucl. Sci. Eng., 26: 547-58(Dec. 1966).

The hydrogenated terphenyl mixture HB-40, which is of interest as a reactor coolant, has been irradiated in a loop in the NRX reactor under conditions simulating those in an organic-cooled reactor. High Boiler decomposition products were removed by distillation and the recovered coolant was recycled to attain a stationary-state composition. Irradiation temperatures ranged from 250 to 375°C. Rates of coolant consumption and properties of the partly decomposed coolant mixture were determined. These are compared with the properties of the terphenyl coolant mixture, Santowax OM, irradiated under the same conditions. Important differences were noted between the properties of the stationary-state coolant mixtures and the properties of the starting materials. The HB-40 mixture appears suitable for use as a reactor coolant at temperatures up to at least 375°C. It has the advantage of remaining liquid under all conditions of use. (auth)

14030 ANALYTICAL CONTINUATION FOR CALCULATING MULTIGROUP-MULTIZONE EIGENVALUE PROBLEMS USING LIE SERIES. Cap, Ferdinand; Schett, Alois (Univ. of Innsbruck). Nucl. Sci. Eng., 26: 517-21(Dec. 1966).

A calculation of the critical volume of cylindrical reactors by means of n-group diffusion theory illustrates the usefulness of Lie series in reactor theory. In the case of Bessel functions of large arguments, analytical methods give rise to numerical dif-

ficulties. An analytical method developed to avoid such difficulties is discussed. Comparatively small computers can be used to solve such problems. (auth)

14031 NIEDERAICHBACH NUCLEAR POWER PLANT (KKN) WITH GAS-COOLED D_2O PRESSURE TUBE REACTOR. 1. FROM THE PLANNING TO THE BEGINNING OF CONSTRUCTION. Tebbert, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Strasser, W.; Plank, H. Atomwirtschaft, 11: 493-7(Aug.-Sept. 1966). (In German).

Planning of the KKN reactor is reviewed. Reasons for selection of the 100-MW(e) gas-cooled heavy water reactor, a description of the site, selection of CO_2 as coolant, fuel element development, and economic aspects are discussed. (M.C.G.)

14032 NIEDERAICHBACH NUCLEAR POWER PLANT (KKN) WITH GAS-COOLED D_2O PRESSURE TUBE REACTOR. 2. ENGINEERING AND CONSTRUCTION OF THE INSTALLATION. Altvater, W.; Preuss, H.-J. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirtschaft, 11: 497-503(Oct. 1966). (In German).

The heavy water-moderated and CO_2-cooled pressure tube reactor has a capacity of 316 MW(t) and 100 MW(e). The reactor building is a double safety shell, which is composed of steel with an outer concrete covering. The coolant system control system, reactor, moderator tank, cooling channels, and fuel element transport system are described. (M.C.G.)

14033 STUDY OF THE POSSIBILITY OF USING THORIUM IN FAST POWER REACTORS. Leipunskii, A. I.; Kazachkovskii, O. D.; Shikhov, S. B.; Murogov, V. M. J. Nucl. Energy: Pt. A and B, 20: 799-809(Sept. 1966).

The results of studying the possibilities of using ^{233}U and thorium in a reactor system with breeding are described. It is shown that the most promising from the point of view of fuel doubling time is the combined use of $^{233}U-Th$ and $^{239}Pu-^{238}U$ in a mixed fast-reactor fuel cycle on condition that the thorium is placed in the shields and ^{233}U, ^{239}Pu and ^{238}U in the cores. The burning and regeneration of ^{233}U and ^{239}Pu in a mixed fuel cycle is effected in such a way that the ratio of the quantity of each remains constant. The doubling time of a system of fast reactors operating on a mixed fuel cycle mode is substantially less than the doubling time of reactors using only ^{233}U and thorium. The main raw material in the mixed fuel cycle is thorium. A method of obtaining isotopically pure ^{233}U with a ^{232}U content $\sim 10^{-4}$ per cent is given. (auth)

14034 SPHEROIDAL REACTOR ANALYSIS. Liu, Tien-chen; Liu, Chung-ching; Chien, Ji-peng (National Tsing Hua Univ., Taiwan). J. Nucl. Energy: Pt. A and B, 20: 779-83(Sept. 1966).

The spatial distribution of neutron flux and the critical volume of an oblate spheroidal reactor is calculated using one-group theory. (H.D.R.)

14035 STABILITY OF COUPLED CORE REACTORS BY THE SECOND METHOD OF LIAPUNOV. Murray, H. S.; Schultz, D. G.; Weaver, L. E. (Univ. of Arizona, Tucson). J. Nucl. Energy: Pt. A and B, 20: 729-34(Sept. 1966).

The Second Method of Liapunov is employed in the non-linear stability analysis of a coupled core reactor system. To insure conservative results, the time delay due to the transport of neutrons between cores is incorporated directly into the Second Method. This, in effect, avoids the use of series approximations for the time delay which may lead to non-conservative results. Regions of stability are determined as functions of the coupling coefficient, intrinsic reactivity contribution, and delay time. (auth)

14036 TRANSIENTS IN LARGE REACTORS. Ergen, W. K. Nucl. Safety, 8: 30-4(Fall 1966).

For superprompt-critical excursions in large reactors consideration of the space dependence of transients yields appreciably different values of energy density than the point reactor model. Techniques for conserving computing-machine time in space-dependent calculations are discussed. Analytical solutions, in terms of elliptic functions, are presented for certain typical cases. (auth)

14037 METAL-WATER REACTIONS. Baker, Louis Jr. (Argonne National Lab., Ill.). Nucl. Safety, 8: 20-5(Fall 1966).

Recent advancements in metal–water reaction investigations are reported for the metals Zr, stainless steel, and Al. Recent studies of the reaction of UO_2 with water and steam are reviewed. Experiments were designed either to study the isothermal reaction with steam or to simulate loss-of-coolant or nuclear-excursion accidents. Recent experiments showed the importance of interactions between the cladding metal or oxides and the fuel UO_2. (auth)

14038 DEVELOPMENT OF BERYLLIA-BASED DISPERSION FUELS FOR THE AUSTRALIAN HTGC PEBBLE-BED REACTOR STUDY. Smith, R. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). 35p. (CONF-661003-20). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

As part of a program to investigate the potential of BeO in high-temperature gas-cooled reactors, the Australian AEC carried out a technical and economic assessment of a fully ceramic 200-MW(e) pebble-bed reactor. The status of materials research on spherical, beryllia-based, dispersion-type fuel elements for this reactor study is reported. An account is given of the reactor concept and the main design parameters, the flow sheets for fabricating and reprocessing fuel elements, and the results of the study of the main materials problems, including the physical and mechanical behavior of oxide dispersions, thermal-stress failure, the effects of irradiation-growth stresses and contact stresses, irradiation performance, and fission product release. It was concluded that the fuel could have adequate performance to meet the technical requirements in the high-temperature pebble-bed reactor environment, but that application in central power stations appears unlikely because of doubtful economic prospects. (auth)

14039 HOMOGENEOUS DIATHERMAL NUCLEAR FISSION REACTOR. Mialki, W.; Wille, R. Canadian Patent 746,110. Nov. 8, 1966. Priority date Nov. 2, 1966, Germany.

Temperatures exceeding 1000°C are exploited in this reactor in which UO_2 fuel and BeO or graphite moderator are dissolved or suspended in a diathermous substance such as glass or metallic oxides in the liquid state. Alternate arrangements put the glass melt in a graphite crucible which serves as a neutron reflector or the glass melt may surround graphite members in a suitable container. A large tube protrudes into the melt for the introduction of gas for agitation, or for refueling. Means are provided for slow rotation of the melt. Heat is removed either by convection of hot gas or circulation of reactor liquid in a heat exchanger. (F.S.A.)

14040 NUCLEAR REACTOR REACTIVITY CONTROL BY BUBBLING GAS THROUGH MODERATOR LIQUID. Whittier, Angus C. (to Canadian General Electric Co., Ltd.). Canadian Patent 741,880. Aug. 30, 1966.

The density of the liquid moderator, which may be varied by changing the number of gas bubbles or voids in it, can serve as a reactivity control means. Gas is bubbled through the moderator under controlled conditions, so that density may be varied at will. A mixture of gases is used, some of which are soluble, so that the bubble size is fairly constant as they rise through the liquid. The gases may be introduced through a porous floor of sintered stainless steel. Other diffusive means are also described for creating voids in the moderator. Methods for recycling the gases are provided. (F.S.A.)

Marine and Portable Power Reactors

Refer also to abstract 13989.

14041 (EUR-3066.d) KERNENERGIE-FORSCHUNGSSCHIFF "OTTO HAHN". Jahresbericht 1965. (Nuclear Powered Ship "Otto Hahn". Annual Report, 1965). (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). Aug. 1966. Contract 009-64-7 PNID. 102p. Dep. mn.

A condensed survey of the most important work and results for the past year as regards the construction and further planning of the research vessel Otto Hahn are included. The first part deals with those operations which relate to the ships' construction and the conventional plant, while the second part gives an account of the progress achieved in the reactor plant and the activities of the main suppliers. (auth)

14042 (EUR-3125.e) NERO DEVELOPMENT PROGRAMME. Report Covering the Period July 1964–December 1965. (Reactor Centrum Nederland, Petten). 1966. 30p. Dep. mn.

The NERO Development Programme was established by RCN and Euratom to prepare a design with specifications for an advanced pressurized water reactor for marine propulsion. The design target is a pressurized water reactor with internal recirculation within the reactor vessel, a thermal rating of 61 MW with a core lifetime of 1200 days at full power, providing superheated steam at a pressure of 40 kg/cm^2. Reactivity control is to be provided by 12 Y-shaped rods in the hexagonal lattice and burnable poison particles incorporated in UO_2 fuel pellets. Other details on the design and first part of the experimental programme are given in EUR-2180.e, and several topical reports, which have been published by Euratom and RCN. (auth)

14043 (NAA-SR-12256(Vol.1)) SNAP SYSTEMS IMPROVEMENT PROGRAM, MERCURY-RANKINE PROGRAM. VOLUME I. Progress Report, July-September 1966. (Atomics International, Canoga Park, Calif.). Jan. 15, 1967. Contract AT(11-1)-Gen-8. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Efforts were continued on the Mercury Rankine Program (MRP) system engineering, component feasibility, endurance and reliability improvement, and system test evaluation. Near the end of the report period, the AEC directed that the scope of the MRP be reduced to include only 10,000 hr endurance tests of two Combined Rotating Unit (CRU)-V units. The accomplishments in CRU analysis, component development, system testing, and the Hg pool boiler test are presented. (H.D.R.)

14044 OPERATING EXPERIENCE OF THE N.S. SAVANNAH IN COMMERCIAL SERVICE. Nucl. Safety, 8: 63-71(Fall 1966).

Operating experience of the N.S. Savannah during the first 6 months (August 1965 to March 1966) of commercial service is described. During this period the ship made four transatlantic voyages to European ports, traveled 39,383 nautical miles, and made 42 different port entries. The reactor was critical more than 83% of the time, and reactor power was available at all times while the ship was under way. The reactor performed faultlessly in all the ship's operations, including heavy rolling and pitching in the roughest seas yet encountered. Experience in heavy weather operation, port operation, maintenance, periodic testing of engineered safeguards, training, radiation control, and radioactive waste disposal is summarized. (auth)

Rocket and Space Reactors

Refer also to abstracts 12838, 13110, 13160, and 13989.

14045 (BMwF-FBK-66-30) STUDIE UEBER EINE ENERGIEVERSORGUNGSANLAGE FUER RAUMFLUGKOERPER MIT EINEM THERMIONIK-REAKTOR ALS ENERGIEQUELLE. (Design Study of a Nuclear Space Power Plant Using a Thermionic Reactor as Energy Source). Haug, W. (Technische Hochschule, Stuttgart (West Germany)). Oct. 1966. 33p. (In German). Dep. mn.

A design study was established for a 50 kW(e)-system with a thermionic reactor providing the energy for an unmanned space vehicle. The present concept is based on literature studies. Design problems are dealt with and data are given as for example the specific mass of the plant or the coolant pressure drop. (auth)

14046 (LA-3494) LOS ALAMOS COUPLED REACTOR EXPERIENCE. Chezem, C. G.; Hansen, G. H.; Helmick, H. H.; Seale, R. L. (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1966. Contract W-7405-eng-36. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The interaction among the cores in a cluster of nuclear rocket reactors and the resulting static and kinetic behavior of the array has been studied analytically. Lumped-parameter models of two-core coupling have been analyzed by neutron pulsing and rod oscillation and their salient features verified at zero power by a variety of measurements on two Kiwi-type reactors operating in proximity. The Kiwi "free-space" coupling coefficients were determined experimentally to be 24.7, 11.9, and 3.3 cents at 6, 9, and 16 ft center-to-center separations. Perturbation of the fission distribution as a result of interaction at equal power was less than 5% at 6 ft. No neutronic instability was found either in the theoretical models or in the experimental behavior. Temperature dependence is introduced into the coupling model based on experimental evidence from the high-power, full-flow operation of a single Kiwi reactor. The temperature-dependent model is then extrapolated to predict the transfer function behavior of both Kiwi and Phoebus clusters under operating conditions. (auth)

14047 (LA-3633) DECONTAMINATION OF TEST CELL "C" AT THE NUCLEAR ROCKET DEVELOPMENT STATION AFTER A REACTOR ACCIDENT. Sanders, Fred W. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Test Cell C, a facility of the Los Alamos Scientific Laboratory at the Nuclear Rocket Development Station, was contaminated by fuel fragments during testing of the Phoebus IA reactor, a prototype nuclear rocket reactor. Approximately 10^7 Ci of radioactive material, at 1 hr post test, was spread over an area of about 5 acres. Decontamination of the test cell required 60 days. The cost of the cleanup was about $100,000, and all participants combined received a total dose of 180 rem. (auth)

14048 (N-66-35211) ANALYSIS OF THE TRANSIENT FLOW OF HYDROGEN IN HEATED PASSAGES IN THE LAMINAR-TURBULENT TRANSITION REGION. Leko, Robert W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1966. 24p. (NASA-TN-D-3629). CFSTI $3.00 cy, $0.65 mn.

A transient analysis was made of the flow characteristics in a single heated tube of circular cross section, and was made in association with phenomena occurring in the nuclear rocket reactor core. Twelve perturbations of heat flux into the tube wall, five perturbations in inlet pressure, and four perturbations of pressure drop were considered. The results are depicted in terms of the phase plane that generalizes the results and illustrates all flow behavior of the laminar instability condition. The external parameters considered, which influence the transient behavior of the system, were inlet pressure, outlet pressure, inlet enthalpy, and heat flux into the tube wall. Five kinds of transients were found. The first corresponds to an initial laminar flow rate on the steady-state curve which when perturbed goes to a turbulent equilibrium point. The second starts from the laminar flow rate on the steady-state curves and terminates at zero flow rate. A third begins from an operating point corresponding to a turbulent flow rate on the steady-state curve and proceeds to an equilibrium point at a higher turbulent flow rate. The fourth is initiated from a turbulent point on the steady-state curves and reaches a stable equilibrium point at a lower turbulent flow rate. The last begins at a turbulent steady-state point and terminates at zero flow. The "stability criterion" near equilibrium points is simply that the four external parameters give an operating point with a positive pressure drop as a function of flow rate slope on the characteristic curves. If this slope is negative or if there is no operating point, then the condition is unstable. (auth)

14049 (NASA-CR-70862) RESEARCH IN AND APPLICATION OF MODERN AUTOMATIC CONTROL THEORY TO NUCLEAR ROCKET DYNAMICS AND CONTROL. VOLUME I. Semi-Annual Status Report. Weaver, Lynn E.; Shultz, Donald G.; Melsa, James L.; Secker, Philip A.; Nordal, Donald M.; Slivinsky, Charles R. (Arizona Univ., Tucson. Engineering Research Lab.). Feb. 1966. 316p. CFSTI $3.00 cy, $0.65 mn.

Includes N-66-19882 through N-66-19885.

Optimal control theory is applied to derive analytical expressions for compensating reactivity control which minimizes an integral quadratic performance index containing system errors and control motions. Various linear and nonlinear reactor models are analyzed. Analog computer studies show the effect of quasi-optimal feedback control in minimizing system errors caused by internal disturbances. In other research, the second method of Liapunov is used to analyze the behavior of high-order control systems. This is accomplished by finding a lower order model whose response closely approximates the response of a higher order system. The model is developed by matching the surfaces described by Liapunov functions of the system and the model. In particular, a second-order model and a third-order model are developed which provide good results for all systems investigated. The second-order model is shown to be similar to the model obtained using phase margin techniques; and of greater importance, the third-order model is shown to be a better approximation to systems than the phase margin and the second order models. Thus this method serves to extend the practical usefulness of the second method from mere stability analysis to relative stability analysis (response of the system) and synthesis. Aspects of the design of optimal feedback systems for linear systems subject to quadratic integral performance criterion are examined with emphasis on regulator and servomechanism problems. In the regulator problem, the optimal design is shown to be a weighted constant feedback of all state variables. For the servomechanism problem, the solution consists of a regulator plus a linear prefitter system. Methods are presented for both the exact and approximate solution of both problems. (J.R.D.)

14050 (TID-23639) TRANSIENT ENGINE SIMULATION PROGRAM. NERVA PROGRAM. (Aerojet-General Corp., Azusa, Calif.). Aug. 1964. Contract SNP-1. 220p. (RN-S-0114). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Transient Engine Simulation Program showing logic, the derivation of equations and operating instructions are given. The program calculates metal and fluid temperatures and stagnation pressure distributions as functions of time and distance. The overall engine system is represented by combining several separate existing mathematical models of engine subsystems (e.g., turbopump, reflector, shield, core, nozzle, hot-bleed port). The program is general and capable of handling design modifications. Program accuracy is shown to be a direction function of input. Good agreement with NRX-A1 and other test data has been shown. The program is in production and is coded in SCAT for the IBM 7094 computer using the Aerojet Kismet monitor. (auth)

14051 (TID-23649) INSTRUMENTATION EVALUATION NRX-A2 TESTS. NERVA PROGRAM. (Aerojet-General Corp.,

Sacramento, Calif.). Feb. 1965. Contract SNP-1. 118p. (RN-S-0193). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The performance evaluation and pre- and post-test evaluation of the Aerojet-General Corporation NRX-A2 Instrumentation Kit is covered in this report. (auth)

14052 (TID-23650) NES EXHAUST PLUME SCALE-MODEL MEASUREMENTS AND FULL-SCALE PREDICTIONS. NERVA PROGRAM. (Aerojet-General Corp., Azusa, Calif.). Nov. 1964. Contract SNP-1. 29p. (RN-S-0168). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The predicted full-scale NES exhaust plume length and exhaust plume thermal radiation flux at proximate surfaces, and the methods used to predict full-scale flame length and thermal radiation from scale-model data are described. Also presented are experimental values of scale-model NES exhaust-plume length, exhaust-plume thermal radiation flux at proximate surfaces, and exhaust-plume emittance. (auth)

14053 (TID-23653) DEVELOPMENT OF NERVA COPPER-CONSTANTAN IMMERSION THERMOCOUPLES. NERVA PROGRAM. (Aerojet-General Corp., Sacramento, Calif.). Dec. 1964. Contract SNP-1. 104p. (RN-DR-0044). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The development of immersion type copper-constantan thermocouples for NRX A2 testing is reported. All significant analyses and testing performed during the development of the copper-constantan thermocouples and the test results are described. (auth)

14054 (TID-23654) NUCLEAR ENGINE ANALYSIS PROGRAM. VOL. I. TECHNICAL DISCUSSION AND PROGRAM NOMENCLATURE. NERVA PROGRAM. (Aerojet-General Corp., Azusa, Calif.). Dec. 1964. Contract SNP-1. 140p. (RN-S-0171). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Nuclear Engine Analysis Program is an IBM 7094 digital computer program which simulates the steady-state operation of the NERVA hot-bleed engine over the full operational range of chamber pressures and temperatures. This program computes the energy balances for all engine components and for the entire engine, as required to satisfy the demanded chamber pressure and temperature. The program output consists of temperatures, pressures, and flow rates throughout the system. In addition, program output such as the turbine inlet temperature, turbine flow rate, hot-bleed flow rate, diluent flow rate, turbopump speed, pump specific speed, turbine power control valve position, nuclear power, engine thrust and specific impulse is obtained. The program is presently in production status and is being used extensively for steady-state analyses of the NERVA engine systems. (auth)

14055 NUCLEAR ANALYSIS OF GASEOUS-CORE NUCLEAR ROCKETS. Plunkett, Thomas F. (Douglas Aircraft Co., Inc., Huntington Beach, Calif.). Nucl. Appl., 3: 178-86(Mar. 1967).

A nuclear analysis of a gaseous-core nuclear rocket engine is presented in which the spatial effects of the cavity liner material, coolant tubes, and structural components, as well as neutron streaming out of propellant inlet and outlet (nozzle) passages, are considered. Calculational methods were evaluated, and multigroup diffusion theory was selected. Two-dimensional diffusion and transport calculations are compared for finite cylindrical cavity reactors having both central and annular nozzle exhausts. A parameter study was made of fuel and reflector materials, core and reflector dimensions, and temperature effects. It was found that extremely high fuel loadings are required for a propulsion reactor; substantial preheating of the reflector is required for startup; and ^{233}U has significant advantages over ^{235}U and ^{239}Pu as fuel in gaseous-core nuclear rockets. (J.R.D.)

14056 SPACE NUCLEAR SAFETY: 1966. Hansen, H. E. Sandia Lab., Albuquerque, N. Mex.). Nucl. Safety, 8: 1-11(Fall 1966).

A general survey is presented of the state of space nuclear safety studies. The recently formed AEC Division of Space Nuclear Systems, which has responsibility for all space nuclear power and propulsion system development, is described. A systematic approach to space nuclear safety analysis is presented, and a basis for acceptable safety guidelines is suggested. The severe environments associated with launch-pad accidents and reentry are discussed, and the safety-analysis steps are briefly described. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 12508 and 13989.

14057 (CEA-R-3072) CHOICE OF OPTIMUM SIZE OF INSTALLATIONS FOR DUAL-PURPOSE PRODUCTION OF DESALTED WATER AND ELECTRICITY, USING NUCLEAR POWER. Gaussens, J. (Commissariat a l'Energie Atomique, Paris (France)). Sept. 1966. 52p. (In French and English). (CONF-651005-26). Dep. mn.

From 1st International Symposium on Water Desalination, Washington, D. C.

A method based on water and power demand curves is used. This leads to the rational allocation of production costs to water and power within a given market. Criteria based on principles of classical economics, are used in selecting desalination methods and plant sizes. On these criteria, normalizing methods for pricing of water and power can be based, while adhering as closely as possible to structure of demand. Examples of such criteria are the maximum profit of the supplier or the maximum satisfaction of the consumers taken collectively. In the first case marginal costs must be equated to marginal revenue, in the second one marginal cost to marginal satisfaction (theory of surpluses). The plant size often determines the choice of desalination process. Therefore the shape of the water demand curve and the economic criterion adopted (public or private ownership, capital restrictions etc.) often determine in this way both size and type of plant. Before deciding on the desalination technique, market surveys and economic analyses are necessary. (auth)

14058 (ORNL-3970, pp 146-8) DESALINATION. Douglas, D. A. Jr. (Oak Ridge National Lab., Tenn.).

The desalination program consists of two main areas of interest. One concerns the reactor and the other the distillation plant. The cost of fabricating a number of different fuel elements were analyzed in an effort to develop the optimum design for producing low-cost steam. Specially shaped tubing for heat-transfer tests were also developed in an attempt to reduce the cost of the evaporation and condensing steps in coverting salt water to freshwater. (auth)

14059 ELECTRIC POWER AND PURE WATER FROM DUAL-PURPOSE NUCLEAR PLANTS. O'Toole, J. D.; Stinson, W. H. (Westinghouse Electric Corp., East Pittsburgh). Westinghouse Eng., 26: 169-74(Nov. 1966).

The design and economics of large pressurized water reactor plant for electric power generation and water purification are discussed. The combination of power generation and water-purification facilities in one plant would require lower investment and have lower operating costs than could be achieved by separation of these 2 processes. Considerations in evaluating nuclear dual-purpose plants are: the status of technology in nuclear steam supply systems; energy costs for such systems; possible turbine-generator configurations and their influence on cost of energy supplied to the water purification plant; the effect of reactor "stretch," i.e., the capability to increase reactor output during its lifetime; and the need for optimization in dual-purpose plants. The number of modules required in typical applications of various PWR sizes is shown. Various configurations are discussed for the nuclear dual-purpose plant, where the turbine serves as a common element to both the nuclear power generation plant and the purification plant. Typical ranges of electrical output that match water production capacities are shown. Designs of various systems are diagramed and their advantages discussed. (BBB)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 13989 and 14014.

14060 (AD-634563) NEUTRON TRANSPORT CALCULATIONS ON AIR FORCE NUCLEAR ENGINEERING TEST REACTOR. Floyd, David R. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Mar. 1966. 93p. (GSP-Phys-66-5). CFSTI $3.00 cy, $0.75 mn.

Thesis.

Neutron transport flux calculations are performed on the test cells of the Air Force Institute of Technology Nuclear Engineering Test Facility at Wright-Patterson Air Force Base, Ohio. The calculations are performed by a computer code, written by the author, which uses a three energy group, discrete S-4 approximation of the Boltzmann transport equation in XY-geometry. An iterative procedure having the total fission source production as the eigenvalue is used by the computer code to solve the derived discrete SN difference equations numerically. The code is written in FORTRAN IV language for the IBM 7094 coupled system. The results obtained by the code calculations are compared with the results from gold foil experiments. These results are in good agreement. (auth)

14061 (AE-254) BUCKLING MEASUREMENTS UP TO 250 DEG C ON LATTICES OF AGESTA CLUSTERS AND ON D_2O ALONE IN THE PRESSURIZED EXPONENTIAL ASSEMBLY TZ. Persson, R.; Andersson, A. J. W.; Wikdahl, C.-E. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1966. 58p. Dep. mn.

Buckling determinations by means of flux mapping were performed in TZ up to 250°C on two lattices of Agesta fuel assemblies in D_2O and on D_2O alone. Most of the flux measurements were made with fission counters in pressure thimbles. The perturbations caused by the thimbles were studied experimentally in various ways and compared with two-group diffusion-theory calculations. In one of the lattices the effectiveness of a control rod (AgInCd) was also investigated. The results of the diffusion length experiments indicated some systematic error of the order of 0.15–0.10 m^{-2} in the bucklings measured, though the temperature dependence should be well established. The bucklings of the two lattices studied (square pitches 24 and 27 cm) were found to be less sensitive to temperature than theoretical calculations predict, the temperature coefficient being more than 10% smaller. The buckling changes from 20 to 250°C were about −2.4 and −1.8 m^{-2}, respectively, for the two lattices. During part of the experimental period about 30% unexplained excess absorption occurred in the heavy water. (auth)

14062 (AE-262) DESIGN AND ANALYSIS OF THE POWER CONTROL SYSTEM OF THE FAST ZERO ENERGY REACTOR FR-0. Schuch, N. J. H. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1966. 72p. Dep. mn.

Fine-control rod power regulation and the design of the control system of the fast zero energy reactor FR-0 are described. System requirements and operational conditions were used as design criteria. Manual and automatic control is possible. Variable electronic end-stops for the control rod were designed, because of the special construction of the reactor and control rod. Noise in the control system from the reactor, detectors, and electronics caused disturbances of the control system at the lower power levels. The noise power-spectrum was measured. Statistical design methods, using the measured noise power-spectrum, were used to design filters, which reduce the influence of the noise at the lower power levels. Root Loci sketches and Bode diagrams were used for stability analyses. The system was simulated on an analogue computer, taking into account even nonlinearities of the control system and noise. Typical cases of reactor operation were simulated and stability analysis performed. (auth)

14063 (AECL-2632) ENERGY DEPOSITION RATES IN ZIRCALOY-2 AND GRAPHITE IN THE NRX REACTOR. Boyd, A. W.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 10p. Dep. mn. AECL $0.50.

Energy deposition rates in Zircaloy-2 and graphite were measured using adiabatic calorimeters in three positions in the NRX reactor. The results obtained and neutron fluxes in these positions are tabulated and discussed. (auth)

14064 (AERE-M-1739(Pt.2)) PRESSURE-DROP CHARACTERISTICS FOR THE FLOW OF SUBCOOLED WATER AT ATMOSPHERIC PRESSURE IN NARROW HEATED CHANNELS. Forgan, R.; Whittle, R. H. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 16p. Dep. mn. BIS $0.60. HMSO 3s.

The results of pressure-drop measurements for water flowing in a heated channel of rectangular cross-section 24 in. long × 1.0 in. × 0.127 in. were presented in Part I. Similar measurements were carried out with channels of similar geometry but with a range of heated lengths and gap widths. A set of measurements was also made with a tubular channel having an I.D. of 0.254 in. The measurements were made to determine the parameters which define the minima in the pressure-drop/flow curves (S-curves), and hence a criterion for assessing the onset of parallel-channel instability. A correlation was derived relating the ratio $\Delta T_c/\Delta T_{sat}$ at the minima of the S-curves to the L_h/D_h of the channel. (auth)

14065 (AERE-M-1819) THERMAL-FLUX VARIATIONS IN THE PLUTO TYPE RESEARCH REACTORS DUE TO CONTROL-ABSORBER MOVEMENT. McGill, I. S.; Crook, M. J. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1966. 22p. Dep. mn.

The thermal-flux variations occurring in the PLUTO-type research reactors owing to control-absorber movement are illustrated by measurements obtained in the DAPHNE zero-energy mock-up. Control by both the original semaphore-arm type coarse-control absorbers and vertical control rods is considered. (auth)

14066 (AERE-M-1820) SOME FLUX MEASUREMENTS IN MOCK-UP POWER-CYCLING RIGS (PLUTO 7V TYPE). McGill, I. S.; Crook, M. J. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1966. 10p. Dep. mn.

Features of PLUTO 7V type power-cycling rigs are illustrated by thermal-flux measurements in two simulated rigs in the 7V4 position of the DAPHNE/PLUTO mock-up. The results support the rule of thumb that a neutron shutter should overlap the test section by at least one dia and should be withdrawn at least one dia beyond the top of the test section. (auth)

14067 (AERE-R-3913) EXPERIMENTAL IN-PILE LOOP TO MEASURE THE RATE OF ESCAPE OF FISSION PRODUCTS FROM URANIUM–GRAPHITE FUEL. Brown, P. E.; Flowers, R. H.; Lupton, D. F. M.; Reid, H. A. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1962. 68p. Dep. mn.

A 3.5 kW purged fuel capsule, was operated in DIDO at 1130°C and 1360°C, employing a compacted U/graphite powder fuel. The loop is described, and the transport of gaseous and solid fission products around the system is shown to be caused by the release of small amounts of Kr and Xe isotopes into the purge system and the diffusion of metals of groups I, II, and III through the graphite fuel can components at high temperature. (auth)

14068 (BNWL-347) MULTIGROUP ANALYSIS OF SELECTED FAST CRITICAL ASSEMBLIES. Little, W. W. Jr.; Hardie, R. W.; Maas, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A modified version of the Russian data compilation is used to compute nuclear parameters for various fast critical assemblies. Calculated and experimental values of critical mass, fission ratios, and reactivity coefficients are compared. For the moderate volume Pu and U assemblies analyzed, the data predict k_{eff} within about 1.5%. (auth)

14069 (CNAEM-36) CALIBRATION OF CNAEM PARAFFIN PILE (SP-1) WITH RESPECT TO THE BNL SIGMA PILE. Ertek, C.; Guersu, Y. (Cekmece Nuclear Research Center, Atomic Energy Commission, Istanbul (Turkey)). May 1966. 20p. Dep. mn.

Brief descriptions of both the BNL Sigma Pile and the CNAEM paraffin pile (SP-1) are given. Experimental procedures are described for absolute neutron flux measurements in SP-1 by gold foil activation. The results are tabulated and compared with similar measurements in the BNL facility. (H.D.R.)

14070 (EUR-3138.e) THE BR2 TESTING REACTOR AND ITS CONNECTED LABORATORIES. Annual Progress Report, 1965. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). July 20, 1966. 38p. Dep. mn.

In 1965, the BR 2 testing reactor operated for 190 days without any noteworthy incident occurring. The reactor core was enlarged in order to obtain more irradiation channels. The maximum thermal neutron flux raised to 10^{15} n/cm² sec, the rated reactor power being 57 MW. Some 150 devices were irradiated during the year so that 35 to 40 channels were continuously occupied in the reactor, mainly for the member states of the European Community, but also for UKAEA and other foreign countries. Reference is made to many irradiation devices developed and fabricated by GEX. The MFBS Loop was put into operation and the first irradiation of a Na cooled Pu-fuel pin was carried out for the Rapsodie project. The dismantling cell was occupied full-time. The medium-activity hot laboratories were to be commissioned and officially opened. (auth)

14071 (GA-6452(Rev.2)) HAZARDS REPORT FOR MODIFIED HTGR CRITICAL FACILITY. Pound, D. C.; Larsen, J. E.; Nichols, P. F.; Nirschl, R. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Feb. 8, 1966. Contract AT(04-3)-167. 167p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Factors considered in an evaluation of the safety of operation of a proposed modified critical facility to be located on Torrey Pines Mesa in San Diego, California, are presented. The facility consists of a split-bed assembly of Al tubes welded into a honeycomb structure and fueled with Al-clad U dispersed in carbon. High-temperature gas-cooled reactor (HTGR) critical experiments are planned to investigate the basic technology of HTGR core physics. Separate sections describe the site, experimental program, facility and building, instrumentation and control, nuclear behavior and accident analyses, and operating procedures and safeguards. (H.D.R.)

14072 (GEMP-472) TEST PROGRAM AND PROCEDURES FOR A MOCKUP AND UF_6 NASA CAVITY REACTOR CRITICAL EXPERIMENT AT THE LOW POWER TEST FACILITY. Pincock, G. D. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 23, 1966. Contract AT(40-1)-2847. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The test program and procedures for an accurate mock-up of a gaseous UF_6 experiment in the cavity reactor using sheet fuel

followed by an actual UF_6 experiment are documented. The fuel radius in both cases will be 24 inches or 0.67 of the cavity radius. Measurements will be made to determine k excess, rod worth, reactor material worths such as fuel, Al, etc., and power and flux distributions in the cavity and reflector regions. The purpose of the experiments is to determine absolute differences between the mock-up reactor using solid sheet fuel and the same system containing gaseous UF_6. (auth)

14073 (GEMP-473) CAVITY REACTOR CRITICAL EXPERIMENT. Kunze, J. F.; Lofthouse, J. H.; Pincock, G. D.; Wood, R. E.; Hyland, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Oct. 7, 1966. Contract AT(40-1)-2847. 25p. (CONF-661001-41). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The critical experiment reactor consists of a cylindrical reflector–moderator tank surrounding a concentric cavity containing a fueled volume of dilute uranium. The split table arrangement with two tanks which provides access to the cavity is shown. Critical masses, power distributions, reactivity worths of mockup heat shields, holes in the moderator tank, and the effects of varying fuel distribution are being studied. The reflector thickness and the cavity size are substantially greater than those in early experiments of this type, and the fuel has been dispersed throughout the specified volume of the cavity in the form of 0.0025-cm-thick Oralloy sheet material, to provide a realistic mockup of a gaseous core concept. (auth)

14074 (IN-1047) CALCULATING REACTOR POWER FROM ACTIVATION TECHNIQUES AS APPLIED TO AN UNUSUAL FUEL GEOMETRY (ATRC). Durney, J. L.; Kaufman, N. C. (Idaho Nuclear Corp., Idaho Falls). Jan. 1967. Contract AT-(10-1)-1230. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two methods for determining reactor power using neutron activation techniques in a low-power reactor are developed and then applied to a particular reactor, the ATR Critical Facility. In one method, fission rate data are taken between fuel bearing plates, the values are graphically integrated, and reactor power is calculated. In the other method, the fuel region is divided into a number of subregions without regard to fuel plate position, a fission rate is measured at a point in each subregion, and these values are appropriately weighted and summed to obtain reactor power. Both methods have proved reliable, but the latter method is more convenient to use since it requires fewer fission rate detectors and allows the use of a digital computer in performing the calculation of power. (auth)

14075 (INR-724/IXA/R) MEASUREMENT OF NEUTRON DENSITY DISTRIBUTIONS IN MULTILAYER UNIT CELLS. III. RESULTS FOR "ANNA" REACTOR CELL WITH WATER, 19.8 CM LATTICE PITCH. Adamski, L.; Jozefowicz, E. T.; Jozefowicz, K.; Eicherif, A. I. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 12p. Dep.

Intracell neutron density distribution in ANNA reactor core with water, 19.8-cm lattice pitch, was measured using the spiral detector method described and discussed in preceding reports. The results are given in the form of distributions of bare and subcadmium copper activities. (auth)

14076 (INR-730/IXA/R) MEASUREMENT OF NEUTRON DENSITY DISTRIBUTIONS IN MULTILAYER UNIT CELLS. IV. RESULTS FOR "ANNA" REACTOR CELLS WITHOUT WATER, 14.0 AND 19.8 CM LATTICE PITCHES. Adamski, L.; Jozefowicz, E. T.; Jozefowicz, K.; Elcherif, A. I. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 16p. Dep.

Intracell neutron density distributions in ANNA reactor cores without water, 14.0- and 19.8-cm lattice pitches were measured using the spiral detector method described and discussed in preceding reports. The results are given in the form of distributions of bare and subcadmium copper activities. (auth)

14077 (JAERI-1072) FIRST FLIGHT COLLISION PROBABILITY IN THE SQUARE AND HEXAGONAL LATTICE SYSTEMS. Takahashi, Hiroshi; Nakayama, Takashi (Japan Atomic Energy Research Inst., Tokyo). July 1964. 14p. Dep. mn.

The first flight collision probability for the square and hexagonal lattices is formulated as the extension of the probability in the cylindricalized cell, which was obtained previously. A method of shortening the calculation time for the probability is described for use with the successive method for determining the length in the lattice system. The code for calculating the probability is also explained. (auth)

14078 (JUL-407-RE) DAS VERHALTEN DES REAKTORS FRJ-1 (MERLIN) BEIM AUSFALL DER ZWANGKUEHLUNG, ZWEITE ERWEITERTE AUFLAGE. (The Behavior of the FRJ-1 (MERLIN) Reactor in the Loss of Forced Cooling. 2nd Enlarged Edition). Muench, E. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Aug. 1966. 62p. (In German). Dep. mn.

The behavior of the FRJ-1 reactor in the failure of the primary coolant circuit pump was investigated for the case when the reactor shutdown was not achieved by the safety system. These studies were made on two different core configurations of different compactness. In normal operation light water in forced circulation was pumped from overhead to the bottom through the core. After pump failure the forced circulation decreased and goes into natural convection, and upward flow. The time from pump failure up to reversal of the coolant flow was determined. This time was shorter with increasing heating circuit charge and reached approximately 7 sec at 75 W/cm^2. The temperature oscillations occurring in the fuel during loss of the forced cooling were explained as a result of the bubble evaporation occurring at higher heating surface charges with the flow reversal. In the output pattern a strong drop limited through temperature effect was observed and on this decrease uncontrollable oscillations were superposed at higher outputs. As origin of these oscillations, subcritical reactivity changes through bubble formation were established. Within 30 min after pump failure no new power rise was observed. No unsafe operational condition of the reactor was found during the studies. (tr-auth)

14079 (KFK-397) SICHERHEITSBERICHT FUER FR2-ABBRANDLOOP (FR2-PROJEKT 26). (Safety Report for FR-2 Burnup Loop (FR-2 Project 26)). Reiser, H. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct. 1965. 82p. (In German). Dep. mn.

An experimental installation with pressurized circuits was put in operation at the FR-2 to permit irradiation and burnup studies with unclad fuel rod samples in the core of the FR-2. The design and construction of the loop is described in detail. The testing of the loop is discussed. The loading and unloading procedures and the operational problems are given. Safety considerations are discussed. (J.S.R.)

14080 (KFK-474) SPECIAL EXPERIMENTAL TECHNIQUES DEVELOPED RECENTLY FOR APPLICATION IN FAST ZERO POWER ASSEMBLIES. Bayer, A.; Seufert, H.; Stegemann, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug. 1966. 41p. (CONF-661019-9). Dep. mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

Three different experimental methods are described for application in fast zero power assemblies. The first method is for the absolute determination of ^{238}U capture rates. The principle is based upon the fact that ^{243}Am and ^{238}U decay via ^{239}Np into ^{239}Pu. The α-disintegration rate of ^{243}Am is determined absolutely by low geometry α-particle counting. From this the absolute ^{239}Np disintegration rate follows directly, which is measured by the 106 KeV γ-x ray coincidence technique, so avoiding radiochemical separation. The γ-x ray self-attenuation within thick U foils is treated quantitatively and an optimum foil thickness is derived. The second method is concerned with the application of resonance activation foils in the KeV-region, where, besides ^{23}Na, the application of ^{19}F and ^{27}Al was found to be interesting. The short half lives of 11.5 sec (^{20}F) and 2.3 min (^{28}Al) require an automatic rabbit-irradiation system by which the irradiated foils were transported immediately between two detectors so that counting could be started 3 sec after the end of irradiation. The third method is used to determine the prompt neutron decay constant, the reactivity, and the absolute reactor power by investigation of the neutron noise. The probability distribution of detector counts in given time intervals is measured by a probability distribution analyzer. The specific feature of this technique is that the complete probability distribution of interest can be measured at once. (J.R.D.)

14081 (LAC-ER-8854) DESIGN AND FABRICATION OF MULTI-SPECIMEN TENSILE TEST LOOPS. Quarterly Report No. 1, July 1, 1966–September 30, 1966. (Lockheed Nuclear Products, Marietta, Ga.). Oct. 1966. Contract NAS3-9609. 56p. CFSTI $3.00 cy, $0.65 mn.

Progress on the design (with appropriate analysis), fabrication and checkout of two multispecimen tensile test loops is reported. These loops are to be used with existing ancillary equipment at the NASA Plum Brook Reactor Facility in programs for evaluating the combined effects of nuclear radiation and cryogenic temperatures on spacecraft structural materials. The loops will each accommodate six test specimens for irradiation and testing in the range 30°R to 540°R at maximum neutron flux levels. These specimens will be distributed symmetrically about the centerline of the loop axis with their axes parallel to the loop axis. The specimens will be loaded, in either tension or compression, individually by water

actuated pistons through individual load sensing dynamometers. The hydraulic engine and dynamometers are placed near the aft end of the loop because of space considerations and to increase their accessibility and also to reduce the radiation to these components. This placement consequently reduces the induced gamma radiation to which maintenance personnel would otherwise be subjected. The design includes temperature sensors placed in the refrigerant lines at the aft end of the loops and an ion-type vacuum pump to dynamically maintain part of the vacuum insulation in the refrigerant lines. Progress to date includes completion of the conceptual design with layouts and location of all components, preliminary stress and thermal analyses and detail drawings of the forward section of the loop, the design of which is the most critical of the various loop sections. (auth)

14082 (NP-16426) ON THE DETERMINATION OF MICROSCOPIC REACTOR PARAMETERS USING AN EXPONENTIAL ASSEMBLY. Kleijn, Hans Robert (Technische Hogeschool, Delft (Netherlands)). 1965. 134p. Dep. mn.

Thesis.

Results of analyses of exponential assemblies used in conjunction with reactors as neutron sources are presented. The practical uses of exponential assemblies are discussed and the LEAD facility is described. A method of simulating boiling water is discussed and the determination of associated moderator void fractions is outlined. Reactor physics problems associated with the use of integral nuclear superheat reactors are examined. Measurements related to resonance escape probability and reactor thermal utilization factors are described. Results of measurements are compared with model calculation results. (J.R.D.)

14083 (NP-16432) ETUDE EXPERIMENTALE DES DEPRESSIONS DE FLUX ET ANTIREACTIVITES CREEES PAR LES DISPOSITIFS D'IRRADIATION. (Experimental Studies of the Flux Depressions and Negative Reactivities Produced by the Irradiation Geometry). Roche, Dominique (Grenoble Univ. (France). Faculte des Sciences). Sept. 25, 1965. 187p. (In French). Dep. mn.

Thesis.

When an irradiation device is placed in a region of the core or the reflector of a reactor it creates perturbations in the neutron flux. Methods for the calculation of the flux depressions and negative reactivities produced by experimental devices irradiated in swimming pool reactors are described. The regions of application of these methods were verified in a number of cases. The mean flux depressions can be calculated by the theory of absorption probabilities or by the scattering theory. The scattering theory has the advantage of giving the distribution of the perturbed thermal flux. The two theories give comparable results that are in good agreement with the experimental values determined on mockups composed of stainless steel and Al and having air spaces. The mockups simulate the majority of the irradiation devices so that the flux depressions can be evaluated rapidly by comparison with these experimental results. The perturbation theory for the calculation of the negative reactivity gives good results in the case of devices not containing too large an air space. The great number of measures made and the diversity of the cases studied permits the rapid determination by comparison of negative reactivities. These measurements showed that the negative reactivity of an irradiation device is principally due to the dimensions and to the material of the exterior tube. By using measurements made with open and closed tubes, the maximum value of the negative reactivity of a device can be deduced from the properties of its exterior tube. (tr-auth)

14084 (NSL-64-187-1964) NEUTRON SPECTRUM MEASUREMENTS FOR THE NORTHROP REACTOR. Levine, S. H.; Olafson, J. H.; Faulkenberry, B. (Northrop Space Labs., Hawthorne, Calif.). July 1964. 70p.

Determinations of the neutron flux energy and spatial distributions in the facility exposure room are reported. A description of the radiation exposure facility is included along with descriptions of foil activation experiments. (J.R.D.)

14085 (ORNL-P-2600) MONTE CARLO CALCULATIONS OF FAST MULTICOMPONENT CRITICAL SYSTEMS. Thomas, J. T. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 12p. (CONF-661019-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

Criticality studies were made of three-dimensional cuboidal systems of U metal cylinders enriched to 93.2 wt % ^{235}U. The systems were composed of nearly identical, individually subcritical components spaced in air. The dependence of the system critical mass upon the mass and shape of the components was examined by utilizing units ranging in mass from 10.5 to 26.2 kg of U and with height-to-diameter ratios from 0.47 to 1.17. The calculation of such assemblies by usual analytic techniques is not practicable, but the systems are ideally suited to Monte Carlo methods. The multiplication factors of a number of the experiments were computed by several codes and the results compare favorably. The one most extensively employed, however, has been the British GEM Monte Carlo code. A brief description of the geometry input and those features of the code applicable to the experimental systems investigated are given, as well as the results of typical experiments and comparison with computation. The computed values of k_{eff} agree with experiment to within 1½%. (auth)

14086 (ORNL-3970, pp 164-78) HIGH FLUX ISOTOPE REACTOR. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

The procedures previously developed at ORNL for fabricating HFIR fuel elements have been successfully transferred to industry. Metals and Controls, Inc., has now fabricated 11 fuel assemblies consisting of inner and outer annuli. Assistance from ORNL was required by the fabricator in working out the production problems, especially in the area of assembly and welding. Over 9000 fuel plates have been produced according to the HFIR specifications. The plate rejection rate has been reduced from more than 20% to about 10%. The final density of an HFIR U_3O_8 dispersion fuel plate is not a function of the compact pressing pressure, since high final densities are being obtained even with pressures as low as 15 tons/in.^{2} The final core dimensions varied with pressing pressures below 25 tons/in.^{2} Two procedures are being developed for adding wire spacers to the HFIR elements. In one, either a steel wire or carbide balls with a diameter larger than the channel spacing are drawn through the channel, cutting grooves in both plates. The spacing wire, also larger than the channel, is then drawn into the grooves. In the second method, wires are ultrasonically welded to flat plates before they are curved and assembled into a fuel element. Small subassemblies were made by both techniques and used for flow testing. Two additional sets of HFIR control plates were fabricated by slight modifications of procedures previously developed. The first set was then assembled into complete control cylinders meeting specifications. Hot-cell examinations were made of miniature control plate samples after irradiation to doses of 2.9×10^{21} neutrons/cm^2 (thermal) and 1.1×10^{21} neutrons/cm^2 (fast). No evidence of any reaction, swelling, or plate deformation was found. The irradiated samples were cut to expose the dispersions and exposed to boiling water. The irradiated samples of the Eu_2O_3 dispersion swelled considerably but less than the controls. As expected, the europium molybdate dispersion did not swell. (auth)

14087 (ORNL-3970, pp 179-84) HIGH FLUX ISOTOPE REACTOR TARGET DEVELOPMENT. Douglas, D. A. Jr. (Oak Ridge National Lab., Tenn.).

The transuranium project is to produce gram quantities of the heavier transuranium elements by successive neutron captures in ^{239}Pu. This nuclide has been converted to ^{242}Pu, ^{243}Am, and ^{244}Cm at Savannah River. Facilities and equipment at ORNL will be used to further irradiate these products and recover the isotopes produced. Target elements containing principally these three nuclides will be fabricated and then irradiated in the HFIR at a flux of approximately 3×10^{15} neutrons cm^{-2} sec^{-1}. The target elements will be reprocessed in the Transuranium Processing Facility (TRU) to recover the product actinides and to recycle the target actinides to the HFIR. Recycle target elements must be remotely manufactured because of the high gamma and neutron radiation associated with the contained nuclides. The tasks have involved the development of suitable targets, the development of procedures for fabricating these target elements under various conditions, and the testing and confirmation of design of the HFIR target element. The irradiation program for confirmation of the HFIR target element design was almost completed, the necessary ^{242}Pu targets were fabricated, and the development of the target fabrication equipment for the TRU was completed. This equipment is now undergoing final testing prior to "hot" operation in the TRU. (auth)

14088 (RT-FI-(66)4) MESURES DE DENSITE ET DE DISTRIBUTION DE PUISSANCE DANS UNE BOUCLE A LIQUIDE ORGANIQUE EFFECTUEES SUR UNE MAQUETTE NUCLEAIRE. (Measurements of the Density and Distribution of the Force in an Organic Liquid Loop in a Nuclear Reactor Core). Gibello, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 26p. (In Italian). Dep. mn.

The problems posed during irradiation experiments in strong flux perturbations are examined. The calculations and the experimental verifications made on a mock-up of 9 UO_2 rods, enriched to 25% in ^{235}U, irradiated in the Ispra-I Reactor are described. In order to determine the neutron flux distribution and the specific power in the test section, as well as the total reactivities due to the introduction of the test section into the reactor, a two-group

lethargy theory was applied. The epithermal fissions were also calculated. Codes for the IBM-704 and 7090 were used by considering simplified models for the test section. The distribution of the specific power was determined by using a non-destructive technique to measure the number of fissions produced in the fuel rods. (tr-auth)

14089 (UCRL-50147) SAFETY ANALYSIS REPORT FOR THE LIVERMORE POOL TYPE REACTOR. Bolstad, J. W.; Cummings, G. E.; Eagan, J. L.; Finn, H. F. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 20, 1966. Contract W-7405-eng-48. 88p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The hazards resulting from a proposed increase in the maximum operating power level from 2 MW to 3 MW of the Livermore Pool-Type Reactor (LPTR) are analyzed. The LPTR is a light-water moderated and cooled heterogeneous reactor having fuel elements of the MTR type. All changes in the facility since the original construction and results of a preliminary test of the reactor operating at 3 MW are included. (H.D.R.)

14090 FREQUENCY CHARACTERISTICS OF A SUB-CRITICAL REACTOR. Dideykin, T. S.; Myznikov, I. V. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 5-10(1965). (In Russian).

Presented are equations and plots for the phase-frequency, and amplitude-frequency characteristics of a subcritical reactor with different degrees of initial subcriticalities. The plots are obtained on the basis of the equations using a fission prompt-neutron lifetime of 5×10^{-6} sec. The results show that at high frequencies the depth of subcriticality greatly influences the variation of the reactivity oscillations with the phase, although the phase-frequency characteristic is also influenced by the subcriticality at lower frequencies. At lower frequencies, an increase in the depth of subcriticality is equivalent to either a decrease in the effective fraction of the delayed neutrons, or to an increase of the decay constant. The dependence of the frequency on the criticality can be used both to monitor the approach of the reactor to the critical state, and for experimental determination of the degree of subcriticality. In the case of the amplitude-frequency characteristics, the effect of the depth of subcriticality is strongest at low frequencies, and this can serve as a practical method of determining the depth of subcriticality for a known amplitude of introduced reactivity, or else to determine the efficiency of the regulator for a specified depth of subcriticality. (ATD)

14091 k_∞ MEASUREMENT OF A NATURAL URANIUM GRAPHITE LATTICE IN RB-1 BY THE NULL REACTIVITY METHOD. Casali, F. (CNEN, Bologna); Ghilardotti, G. Energ. Nucl. (Milan), 13: 480-90(Sept. 1966).

Measurement of the infinite multiplication constant is described for a natural U graphite lattice, similar to the old Brookhaven lattice, carried out in the critical assembly RB-1, by the null reactivity method. With respect to past measurements of this type, the experimental procedure and the interpretation of the results were made more consistent and complete. The modifications introduced are discussed in detail. A preliminary assessment was also made of the effect of spectrum mismatching. (auth)

14092 KYOTO UNIVERSITY NUCLEAR REACTOR ONE YEAR AFTER CRITICALITY. Shibata, Shunichi (Kyoto Univ.). Genshiryoku Kogyo, 12: No. 2, 33-8(Feb. 1966). (In Japanese).

In operation of the Kyoto University reactor, a variety of difficulties has arisen. Fluctuations in the power output, owing to too small a reactivity of the control rod used for skimming, were satisfactorily repaired for safe operation of the reactor. The electromagnets for driving the control rods often failed to operate due to the breakage of the coils, caused by humidity and high temperature, but unless the construction of the reactor itself is altered, this cannot be avoided. The shielding of the beam tubes presented several problems, but a new device made it possible to obtain monoenergetic high-intensity neutron beams. Installation of slant irradiation holes, irradiation baskets, horizontal irradiation holes, and irradiation holes on the heavy water side in the future are planned. The nuclear reactor has been used mainly for experimental and research works. (NSA of Japan)

14093 THE ECONOMICS OF UO_2 FUEL FOR RESEARCH REACTORS. Lumb, R. F. (Western New York Nuclear Research Center, Buffalo); MacPhee, J. Nucl. Appl., 3: 157-66 (Mar. 1967).

The factors affecting fuel cycle costs for research reactors are reviewed and discussed. An analysis and comparison is made of the costs associated with operation at 5 MW of U-Al- and UO_2-fueled reactors. A similar analysis and comparison is made for 1-MW operation of U-Al-, U-Zr-H-, and UO_2-fueled reactors. Costs are plotted for operations over the power range of 1 to 5 MW and for utilization levels of 8, 16, and 24 hr/day. Results indicate that U-Al fuel is most economic at low power and low utilization, and that UO_2 has a decided economic advantage above 250 to 300 MWd/year. (auth)

14094 EXPERIMENTAL STUDY OF BOUNDARY REGION BEHAVIOURS IN MULTI-REGION CORES. Kobayashi, Setsuo; Wajima, Tsunetaka (Hitachi Ltd., Tokyo). Hitachi Hyorōn, 47: No. 12, 7-18(Dec. 1965). (In Japanese).

Ten different cores of the two-region type were prepared, for the experimental light-water moderated critical facility. Two different types of fuel rods (1.5 and 2.5 wt % enrichments) and five different fuel-grids with water-fuel volume ratios of 0.45 to 3.5 were employed. The experiments were performed mainly on reactor statics in the boundary regions. The results of experiments were compared, using the approximation method, with those usually used in reactor nuclear design. The limits of applicability and problems of the calculational methods were examined. It was found that calculation results agreed with the measured critical amounts within the accuracy of about 1% in $\Delta k/k$ (equivalent to about 5% of fuel). For the neutron-flux distribution and the spatial energy spectrum, there was a considerable discrepancy, 10% maximum between the experimental and the calculational values, particularly in the boundary regions. (NSA of Japan)

14095 RAPSODIE, FIRST STAGE OF THE DEVELOPMENT OF THE FAST-BREEDER SERIES. Rozenholc (CEA, Paris); Chauvin; Ertaud; Labat. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 61, 34-44(Sept.-Oct. 1966). (In French).

The units constituting RAPSODIE are described with a consideration of their function and performances and the contribution of industry to their study and development. The contribution of RAPSODIE to the fast-breeder series and the principal problems of PHENIX are discussed. (J.S.R.)

14096 TIME-DEPENDENT NEUTRON FLUX IN PULSED MULTIPLYING ASSEMBLIES. Judge, F. D.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. Nucl. Sci. Eng., 26: 472-86(Dec. 1966). (RPI-328-39 (Rev.)).

The variational method is used to reduce the general time-dependent Boltzmann equation to a multigroup (with overlapping or nonoverlapping) form. The variation of the fundamental decay rate with material properties is then studied. The relation between energy and space transients in pulsed multiplying and pulsed moderating systems is investigated. To augment the theoretical treatment of the asymptotic decay in a pulsed multiplying system, the Nelkin buckling expansion solution for the Fourier transformed transport equation for 1/v absorption is extended to include non-1/v absorption and fission. The development of an improved calculation procedure (DP-L multigroup overlapping or nonoverlapping) for determining the space and time dependence of the neutron flux in pulsed multiplying systems is described. This method is applied to the analysis of recent pulsed spectra measurements. The duration of the energy and spatial transients and the variation of the vector flux distribution from the center to the edge of an assembly are described quantitatively. It is demonstrated that spatial asymmetries in the flux could exist after the flux distribution appears asymptotic. (auth)

14097 SPATIAL VARIATION OF THE FAST NEUTRON FLUX IN CELLS OF SLIGHTLY ^{235}U-ENRICHED-URANIUM WATER-MODERATED LATTICES. Hardy, J. Jr. (Westinghouse Electric Corp., West Mifflin, Pa.); Klein, D.; Dannels, R. Nucl. Sci. Eng., 26: 462-71(Dec. 1966).

The intra-cell structure of the fast neutron flux was measured in several TRX lattices with ^{238}U (n,fission) and Al (n,α) detectors. The lattices were light-water-moderated, with cylindrical, 0.387-in.-dia fuel rods of slightly enriched U. The fuel rods were arranged in hexagonal arrays, with H_2O:U volume ratios of 1.0, 2.35, 4.02, and 8.1. Measured activation shapes and integral fast advantage factors were compared with calculated results obtained with the MOCA2A Monte Carlo program. Agreement was very good. A one-group Monte Carlo calculation and a one-group collision-probability model were found to perform well in comparison with MOCA2A. (auth)

14098 THE PTB RESEARCH AND TEST REACTOR. Kostrzewa, S. (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.). Atomwirtschaft, 11: 504-6(Oct. 1966). (In German).

The PTB reactor is a 1-MW swimming pool type. The reactor core, arrangement of reactor facilities, and experimental program are discussed. (M.C.G.)

14099 ACCIDENT AND SELF-REGULATION STUDIES OF PULSED FAST REACTORS. Randles, J. (EURATOM, Ispra, Italy). J. Nucl. Energy: Pt. A and B, 20: 713-28(Sept. 1966).

A previously developed theory of pulsed fast reactor kinetics, inclusive of feedback effects, is reduced to a simple form and a standard method is applied to obtain a numerical description of

pulsed excursions. This method is embodied in a FORTRAN computer program which executes the arithmetic for any desired number of cases and presents all physical variables of interest as a function of the time during a pulse. The main qualitative ideas underlying the theory are illustrated by numerical examples, in particular, the competition for dominance between a prompt positive Doppler and delayed axial thermal fuel expansion effect and the excitation of elastic waves in the fuel slugs are both brought out clearly. It is shown that, in accident conditions, a fast pulsed reactor similar to the proposed Euratom system SORA possesses a strong net negative feedback which makes the system self-regulating with respect to the fuel temperature, but that such feedback does not appreciably raise the reactivity pulse amplitudes responsible for serious damage. The effect of drifts in the base reactivity is discussed and the reaction of the safety shutdown system is considered. It is concluded that systems similar to the SORA reactor have to be designed so that all possible drifts are far below 2% Δk/sec. In connection with the general question of the choice of the fuel material for a pulsed fast reactor, it is shown that, from the safety viewpoint, the value of the coefficient of thermal expansion of the fuel can be ignored. Thus, all other things being equal, a ceramic is as good as a metallic fuel. (auth)

14100 THE PILE-NEUTRON BURN-UP CROSS SECTION OF ^{149}Pm AND SAMARIUM POISONING. Kondurov, I. A.; Gracheva, L. M.; Egorov, A. I.; Kaminker, D. M.; Nikitin, A. M.; Petrov, Yu. V. J. Nucl. Energy: Pt. A and B, 20: 814-17(Sept. 1966).

The burn-up cross section for ^{149}Pm for a high-flux reactor was determined by observing the build-up of ^{150}Pm which is produced from ^{149}Pm by thermal neutron irradiation. The radioactive ^{149}Pm was obtained from ^{148}Nd using the reaction $^{148}Nd(n,\gamma)^{149}Nd \xrightarrow{1.84\,hr} {}^{149}Pm$. The ^{149}Pm sample so obtained was irradiated in a flux of 10^{14}n/cm^2 sec in a water cavity of the VVR-M reactor. After irradiation, the sample was purified and transferred to a NaI(Tl) scintillation γ spectrometer. Measurements were made over a period of 72 hr. The ^{150}Pm activity is identified from the γ spectrum thus obtained. The results of the experiment can be used to determine the amount of stable ^{149}Sm poisoning in the reactor. (S.F.L.)

14101 NUCLEAR SAFETY. Volume 8, Number 1. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P. (eds.). Contract W-7405-eng-26. One of the five Quarterly Technical Progress Reviews published for the Division of Technical Information, USAEC. Oak Ridge National Lab., Tenn., Fall 1966. 94p. GPO $1.00 Domestic, $1.20 Foreign.

Separate abstracts were prepared on 8 papers. (C.H.)

For abstracts of individual papers see: 12798, 12883, 14036, 14037, 14044, 14056, 14120, and 14121.

14102 NEUTRON KINETICS OF A REFLECTED BURST REACTOR. Coats, Richard Lee. Norman, Okla., Univ. of Oklahoma, 1966. 142p.

Thesis.

The kinetic behavior of burst reactors is universally described by the six delayed group, single energy, space independent kinetics equations. The application of these equations to a reactor which is in the proximity of a reflecting surface can lead to error in the measurement of nuclear parameters and in predicting the kinetic behavior of a burst reactor in the region of prompt critical. A model which adequately accounts for the effect of the reflector is needed. A model is developed which accounts for the reflector affect by the addition of extra parameters similar in form to the parameters of the normal six group, single energy space independent kinetics model. A scheme by which these parameters can be calculated is presented. The model is verified by an experimental investigation. Significant departures from the results of previous experimental investigations are noted. These departures are predicted by the model. The experimental work was done on the Sandia Pulsed Reactor, SPR-I. Reflector materials investigated were polyethylene as a moderating reflector and steel as a non-moderating reflector. A parameter study using the polyethylene reflector was made by investigating several thicknesses at each of several distances from the core. The burst behavior predicted by the model was essentially duplicated by the experimental results. (auth)

Production Reactors

Refer also to abstract 13989.

14103 (ORO-3414-2) EFFECTS OF GEOMETRY FOR DEPOSITION OF RADIOACTIVE MOLECULES FROM STAGNANT GAS IN CONTAINMENT VESSELS. Progress Report No. 2. Ozisik, M. Necati; Chen, Paul C. Y. (North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering). Aug. 1966. Contract AT(40-1)-3414. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Effects of geometry on deposition of radioactive molecules from stagnant gas to the vessel walls are theoretically investigated for three different geometries: parallel plates, long cylinder and sphere. In formulating the boundary value problem, it is assumed that the diffusion flux in the immediate vicinity of the wall surface is proportional to the concentration of radioactive molecules in the gas; and the effects of removal of molecules from the wall surface are also included in the boundary condition. Finite integral transform technique is employed to reduce the coupled partial differential equations to a single integral equation. For perfect sink condition at the wall surface analytical solutions are obtained. For imperfect sink condition, the integral equation is represented in the finite difference form, which is then solved with a digital computer for the concentration of radioactive molecules deposited on the wall surface. The general formulation of the problem for the three different geometries investigated are all represented in the same form, but they differed only through the eigen values for use in these relations. It happens that the eigen values for parallel plates are the lowest, and for sphere the highest. Thus, the quantity of deposition at any time for these three different geometries having the same characteristic length is highest for the parallel plates, and lowest for the sphere, the long cylinder having a value between them. Theoretical results of long cylinder model were compared with the experiments obtained from the deposition test performed in a Nuclear Safety Pilot Plant at the Oak Ridge National Laboratory. The agreement between the theory and the experiment was acceptable. (auth)

Reactor Components, Fuels and Accessories

14104 (AAEC-TM-332) REVIEW OF FLUID FLOW DISTRIBUTION THROUGH RANDOMLY PACKED BEDS. Price, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1966. 24p. Dep. mn.

The literature on fluid flow distribution through randomly packed beds is reviewed in relation to feasibility studies of pebble bed reactors. The methods of measurement used are discussed and existing theoretical solutions are appraised. The experimental data of different observers are in poor agreement. Existing theoretical derivations are found to be inadequate for general application. An alternative theory is proposed which relies upon experiment to specify a boundary condition. The existing superficial velocity profiles can be reasonably predicted in terms of the center line velocity provided this boundary condition is allowed to vary. (auth)

14105 (BNWL-348) INTERIM REPORT ON CONTROL PROGRAM DEVELOPMENT. Kosorok, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Hardware and software requirements of a successfully implemented direct digital control program for multiloop control are defined. Test results of the program with a simulated process show that sampling intervals of one-twelfth to one-fifth the effective process time constant give stable control for a process having an effective dead time approximately equal to the process time constant. (auth)

14106 (CEA-R-3041) MESURE DE LA TEMPERATURE A COEUR EN PILE D'UN CRAYON EL 4-IER JEU. (GAINE ACIER INOXYDABLE, NUANCE 347-EPAISSEUR 0.4 mm COMBUSTIBLE UO_2-DIAMETRE 11 mm). DETERMINATION DE L'INTEGRALE DE CONDUCTIBILITE THERMIQUE APPARENTE DE L'UO_2 EN PILE. (Measurement of the In-Pile Core Temperature of an EL 4 Pencil Element. First Charge (Can of Type-347 Stainless Steel, 0.4 mm Thick; UO_2 Fuel, 11 mm Diameter). Determination of the Apparent Thermal Conductivity Integral of In-Pile UO_2). Lavaud, Bernard; Ringot, Claude; Vignesoult, Nicole (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 58p. (In French). Dep. mn.

The core temperature of a pencil fuel element depends on the thermal conductivity of the UO_2, and on the UO_2–can contact. This temperature may be known accurately only if in-pile tests using the actual geometry are carried out. The test described concerns the measurement of the core-temperature of an EL 4 fuel element, first charge, having a stainless steel can. This temperature is measured at the center of the in-pile pencil element using a high-temperature thermocouple (W–Re with Ta sheath). The element is subjected to operating conditions similar to those of EL 4, both

for the specific power and the can temperature and for the pressure acting on the can. The specific power is obtained in the EL 3 reactor using a slightly higher enrichment for the UO_2 than that planned for EL 4. The required can temperature and pressure are obtained using a Zircaloy 2 irradiation container filled with NaK, adapted for use in the EL 3 reactor. The core temperatures of the UO_2, and that of the can surface are measured. The power is calculated from the heat exchanges in the container calibrated in the laboratory. The temperature drop at the UO_2–can interface is deduced from laboratory measurements carried out under comparable heat flux conditions, and in a gas atmosphere corresponding to the beginning of the life-time of the fuel element. It is possible to draw an integral conductivity curve. It is also possible to check the temperature distribution in the oxide, as deduced from the thermal conductivity integral, by micrographic examination of the oxide structure. (auth)

14107 (EUR–2967.f) VALEUR DU PLUTONIUM A LONG TERME. (Long-Term Value of Plutonium). (Commissariat a l'Energie Atomique, Paris (France)). Sept. 1966. 302p. (In French). Dep. mn.

The main technical and economic data on the fabrication of Pu fuel elements, the production of this metal in reactors, and its extraction from irradiated fuels are reviewed. In order to formulate the problem of long-term value, a simulation model is constructed of an elementary mechanism of price formation between a producer and a consumer reactor. A further study of this general model would make it possible to consider the relations between several optimized reactor-groups. The complexity of this study would lie in the calculation of the Pu equilibrium prices. Finally, certain supplementary studies are mentioned which could be undertaken in order to better define the long-term value of Pu. (auth)

14108 (EUR–3120.e) RESEARCH ON THE INFLUENCE OF CONDITIONS OF FLOW, SUBCOOLING, AND COMPOSITION ON THE BURNOUT HEAT FLUX OF POLYPHENYL REACTOR COOLING AGENTS. van Meel, D. A.; van Gasselt, M. L. G. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). June 6, 1966. 50p. Dep. mn.

Research on forced convection non-boiling, subcooled boiling- and subcooled burn-out heat transfer and pressure drop of terphenyl mixtures in vertical test sections is summarized. Recommended correlations are presented for heat transfer and pressure drop, for upflow through the round 5 mm vertical tube, 500 mm in length. (auth)

14109 (EUR–3123.e) BURNUP DETERMINATION OF NUCLEAR FUELS. Annual Report, 1965. Bresesti, M. (ed.) (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 20, 1966. 76p. Dep. mn.

A project to develop methods for the determination of burnup of nuclear fuels is described. Several methods were investigated including measurement of ^{235}U depletion, determination of fission products and Pu by α and γ spectroscopy, and flux monitoring with Co. Nuclear codes were utilized to calculate neutron energy distributions in the fuel elements. The first results obtained in the analysis of irradiated UC samples are presented. (auth)

14110 (EUR–3124.i) RISOLUZIONE NUMERICA DELL'-EQUAZIONE INTEGRALE DEL TRASPORTO NELL'APPROSSIMAZIONE A UNA VELOCITA E SCATTERING ISOTROPO, PER UNA CELLA QUADRATA CONTENENTE UN ELEMENTO A CLUSTER DI QUATTRO BARRETTE. (Digital Solution of the Integral Transport Equation in the One-Velocity and Isotropic Scattering Approximation, for a Square Cell Containing a Four-Rod Cluster Element). Corona, R.; Montagnini, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 66p. Dep. mn.

A numerical solution of the one-velocity integral transport equation in two-dimensional x-y geometry is presented. A square cell with a four-rod cluster fuel element is considered. The IBM 7090 code ZIP ZIP 3 is presented which is used to evaluate the pointwise flux in the cell and the average fluxes in the fuel and the moderator. (auth)

14111 (GA–7062) ADVANCED BERYLLIUM OXIDE CONCEPTS. Quarterly Progress Report for the Period Ending March 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 25, 1966. Contract AT(04-3)-187. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work on design of the EBOR test module incorporating BeO-matrix fuel was terminated. Work on BeO-matrix fuel was continued to demonstrate its usefulness as an alternative fuel concept for gas-cooled reactors. Emphasis was placed on studies of mechanical properties and fission product retention capabilities of these fuels. Data and information concerning research on the EBOR test module before termination of the work is included. (J.R.D.)

14112 (GAMD–7397) TAMER: A COMPUTER PROGRAM USED IN STUDYING CORE THERMAL CONDITIONS DURING PLANT TRANSIENTS. Read, J. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 6, 1966. Contract AT(04-3)-633. 209p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer code TAMER (Transient Analysis of Multiple Elements with Reverse Flow) was developed for studying nuclear reactor core thermal conditions during plant transients. The code is designed to compute the flow division among various ages of fuel regions and then calculate the temperature distribution for the coolant and fuel elements. The computations account for natural convection as well as forced convection conditions. (auth)

14113 (ORNL–3970, pp 204–8) REACTOR EVALUATION. Douglas, D. A. Jr. (Oak Ridge National Lab., Tenn.).

Fuel fabrication costs and performance are being evaluated for potential reactor systems. The library of computer programs for estimating fuel fabrication costs has continued to expand to cover added types of fuel elements. Fuel costs were estimated and performance was predicted for various fuel elements proposed for heavy-water-moderated organic-cooled reactors. (auth)

14114 (WAPD-TM–547) CYGRO-2: A FORTRAN IV COMPUTER PROGRAM FOR STRESS ANALYSIS OF THE GROWTH OF CYLINDRICAL FUEL ELEMENTS WITH FISSION GAS BUBBLES. Friedrich, C. M.; Guilinger, W. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1966. Contract AT(11-1)-Gen-14. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The digital computer program CYGRO-2 provides a method of structural analysis for an oxide-fueled, metal clad rod-type fuel element in a pressurized environment. Stresses and strains are determined in a cross-section of fuel and clad undergoing thermal expansion and irradiation growth. Elastic, plastic, and creep parameters are used to calculate the effects of temperature, pressure, solid fission product growth, and gas bubble expansion. The axially symmetric fuel may have radial zones and a non-fissionable core or void. (auth)

14115 (WAPD-TM–569) GLUB-1: A FORTRAN-IV DIGITAL COMPUTER PROGRAM FOR WATERLOGGED FUEL ELEMENT ANALYSIS. Dunckhorst, F. T.; Lynn, L. L.; Coffman, W. A.; Meyer, J. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1966. Contract AT(11-1)-Gen-14. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A FORTRAN-IV digital computer program for examining the possibility of excessive clad sheath distortion in a waterlogged fuel rod subjected to a power transient is described. The program solves heat transfer, linear elastic stress and deformation, and defect flow equations to yield transient values of internal pressure, clad stress, and clad strain. Details of the computational model, instructions for input preparation, and some comparisons of calculated results with experimental observations are presented. (auth)

14116 (WAPD-TM–618) FIGRO: FORTRAN-IV DIGITAL COMPUTER PROGRAM FOR THE ANALYSIS OF FUEL SWELLING AND CALCULATION OF TEMPERATURE IN BULK-OXIDE CYLINDRICAL FUEL ELEMENTS. Goldberg, I.; Lynn, L. L.; Sphar, C. D. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

FIGRO is a FORTRAN-IV program for the analysis of fuel volume swelling and the calculation of temperatures in bulk-oxide cylindrical fuel elements. The fuel pellet may be solid, annular, or contain two radial zones. Oxide fuel thermal conductivity is a function of temperature, depletion, and porosity; fuel swelling is a function of temperature, depletion, internal hydrostatic pressure, and fissioning rate. As a boundary condition for the heat conduction equation, either the clad surface flux or the temperature at the inside radius of the fuel may be specified. Two sample problems are presented as test cases for the program deck and to exhibit the features of the input and output. (auth)

14117 STUDY ON THE APPLICATION OF TRACER SYSTEMS TO LOCALIZE FAILED FUEL ELEMENTS. Henzel, N.; Kadner, M.; Kalix, E. (Battelle-Institutes, Frankfurt am Main). Atomkernenergie, 11: 357–66(1966). (In German).

Conventional methods for locating failed fuel element cans based on the measurement of fission product activities are compared with the radiotracer method. The radiotracer method requires labeling the fuel elements of a reactor with appropriate tracers which are activated within the core by n, γ reaction and which can be identified in the coolant by means of radiation detectors in case of a defective can. Theoretical considerations show that the amount of possible tracer combinations is not sufficient to definitely label the fuel elements of gas-cooled and liquid metal-cooled reactors. Of the 13 tracer compounds appropriate for water-cooled reactors, about seven only can be determined by directly measuring their

activities due to the presence of fission products and contaminants. Thus, in water-cooled reactors labeling can be achieved by using enrichment techniques. As pointed out for two nuclear reactors serving as examples, the neutron economy will not deteriorate essentially by the application of the radiotracer method. (auth)

14118 ON BURNUP CHARACTERISTICS OF D_2O-MODERATED, Pu-FUELED LATTICE. III. PLUTONIUM RECYCLE. Shindo, Riyuiti; Yasukawa, Shigeru (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 481-5 (Sept. 1966). (In Japanese).

A study made on Pu recycling is described. The first cycle has U as fuel, and Pu derived from this cycle is used in the second cycle, mixed with U. If the fuel of the first cycle is 0.9% enriched and the second cycle results in a further enrichment of 0.9% by mixing natural U with the Pu out of the first cycle, phoenix Pu can be won from the consumed fuel of the second cycle. (auth)

14119 DISCUSSION ON THE CALCULATION OF NUCLEAR FUEL COSTS. Gudehus, H. Atomwirtschaft, 11: 512(Oct. 1966). (In German).

Relations developed previously for calculation of fuel element costs are re-evaluated. Costs of the reserve elements, taxes and duties, and other economic aspects are considered. Examples are given. (M.C.G.)

14120 IGNITION AND COMBUSTION OF REACTOR FUELS, COOLANTS, AND STRUCTURAL MATERIALS. Peterson, Sigfred. Nucl. Safety, 8: 25-30(Fall 1966).

Oxidation reactions that could occur in accidents in the nuclear industry are reviewed briefly. Conditions for and consequences of ignition are emphasized. Materials treated include reactor fuels and structural metals used in nuclear reactors, as well as alkali metals, graphite, and other combustible materials. Significant documents issued during the review period include a thorough analysis of the fire hazard of Be and an extensive study of the explosive tendencies of powdered metals. (auth)

14121 EVALUATION OF THE IGNITION TEMPERATURE OF ACTIVATED CHARCOALS IN DRY AIR. Kovach, J. L.; Green, J. E. Nucl. Safety, 8: 41-6(Fall 1966).

Properties of activated C that influence the ignition temperature in dry air are evaluated, and a method and equipment for charcoal ignition-temperature measurement are described. A theoretical explanation based on the experimental data is given for the contributing effects of charcoal surface area, ash content, particle size, and bed depth at various air velocities. Methods for increasing the ignition temperature of activated charcoals are discussed. Careful selection of the charcoal for a reactor containment application is needed to minimize the fire hazard. (auth)

14122 FUEL ENDURANCE AND FUEL CYCLES IN MAGNOX REACTORS. Johnson, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). 20p. (CONF-178-10). ORAU.

From European Atomic Energy Society's Symposium on Fuel Cycles for Power Reactors, Baden-Baden, Ger., Sept. 1963.

The data required by a fuel cycle designer is discussed and its availability is considered in relation to decision timing. The interaction between flux, temperature, and irradiation patterns caused by different refuelling policies is considered and calculation methods are described and examples shown. The advantages to be gained by increasing the degrees of freedom available to the operator are shown, and in particular the economic advantage of flexibility in enrichment. Various refuelling schemes both for continuous and batch refuelling methods are described together with the practical problems of on-load and off-load refuelling. The different refuelling policies are compared from the point of refuelling costs and the state of knowledge of the plant parameters. (auth)

14123 MIXED-SPECTRA TYPE REACTOR. Yokomi, Michio (to Hitachi, Ltd.). Japanese Patent 1966-3040. Feb. 23, 1966. Filed Dec. 4, 1962.

An improved mixed-spectra type reactor is proposed. This type of reactor consists of a central, fast-neutron reaction region, an outer thermal-neutron reaction region, and a middle region having fuel with a small concentration of fissile material and moderator. The neutron-energy moderation in the buffer region can be adjusted. (NSA of Japan)

GENERAL

14124 (BNWL-SA-798) WASHOUT COEFFICIENTS FOR SILVER IODIDE. Engelmann, R. J.; Hagen, D. I.; Haller, W. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 21, 1966. Contract AT(45-1)-1830. 13p. (CONF-670106-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 47th Annual Meeting of the American Meteorological Society, New York.

Six washout coefficients for silver iodide particles have been measured in light snow, and one in rain. These are on the order of 2×10^{-6} sec^{-1} for a snowfall of 1 mm/hr, and appear to be related to precipitation rate. Although not large, the washout is significant when determining cloud seeding success from the silver content of snow samples. Calculations are given of the area of snowfield contaminated to a chosen level of silver through the process of washout. Naturally occurring silver backgrounds are also presented. (auth)

14125 (K-1685) DMIN1 AND DMIN2: TWO SUBROUTINES FOR THE UNCONSTRAINED MINIMIZATION OF A FUNCTION OF SEVERAL VARIABLES. Stewart III, G. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 19, 1967. Contract W-7405-eng-26. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This report contains descriptions and listings of the FORTRAN IV subroutines DMIN1 and DMIN2 for the unconstrained minimization of a function of several variables. The programs are based on a method of Davidon. (auth)

14126 (NAA-SR-Memo-12235) PCSQ: A SUBROUTINE FOR DETERMINING THE CHI-SQUARE PROBABILITY. Beller, L. S. (Atomics International, Canoga Park, Calif.). Nov. 8, 1966. Contract AT(11-1)-Gen-8. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This memo describes a subroutine computer program to assist in performance of the χ^2-test. Given χ^2 and the number of degrees of freedom, the routine finds the corresponding probability, P, by a table-look-up procedure. The necessary user information, listings and examples of use are given. (auth)

14127 (NP-16420) BERICHT FUER DAS JAHR 1965. (Report for the Year 1965). (Kernforschungsanlage, Juelich (West Germany)). 192p. (In German). Dep. mn.

The basic organizations and services of the Juelich nuclear research installation are outlined. The contributions of the Juelich nuclear research installation to the Th gas-cooled high-temperature reactor project and the development of fuel particles and fuel elements are described along with irradiation and post-irradiation studies on fuel elements, and studies on graphite. Two steam generators were tested with respect to their flow and thermodynamic behavior. Experimental and theoretical results were reported by the research divisions on the analysis of the genetic, physiological, and biochemical basis of radiation resistance, the direct effect of radiation on cells, organs, and the entire organism, the increase or reduction of radioinduced damage by treatment of plants or animals with procaine hydrochloride and other substances, reversible damage patterns of irradiated tissue cultures, analysis of the distance effect in irradiated chicken embryos, and cytological basic research on delayed radiation damage, radiotherapy, enrichment of stable isotopes, transport properties of molten salts, radiochemical studies in the gas phase, radiolysis of CO, physical chemistry of the actinide elements, neutron activation analysis, development of a method for ^{36}Cl-preparations with high specific activity, recoil chlorination of simple aromatic compounds, hot reactions of recoil tritons in methylamine, radiochemical modifications of inorganic solids, Tc chemistry, measurement of the photofission of deuterons, polarization of recoil protons in π^0 production, π^0 photoproduction at various energies and angles, study of $p\bar{p}$, γp, and $\pi^+ p$ reaction, effective cross section for photo processes, development of gas filled mass separator for fission products, studies in chemical technology, high energy physics, nuclear physics, reactor construction elements, irradiation loop, radiation effects on metals, reactor development, theoretical studies in plasma physics, production of high temperature plasmas, acceleration of plasmas and plasma drives, collision waves and non-linear waves in collision free plasma, expansion of experimental installations at the FRJ-1 and FRJ-2 reactors, development of radiation tube devices, processing of radioactive materials, and studies on applied mathematics. The electronic equipment developed for specific experiments is indicated and the radiation protection methods used are discussed. The publications made during the year are tabulated. (J.S.R.)

14128 (NP-16468(Vol.1)) NINTH GENERAL REPORT ON THE ACTIVITIES OF THE [EUROPEAN ATOMIC ENERGY] COMMUNITY, MARCH 1965–FEBRUARY 1966. (European Atomic Energy Community). Apr. 1966. 116p. Dep. mn.

The activities of the European Atomic Energy Community (Euratom) in the development of nuclear industry for the period March 1965 to February 1966 are reported. Topics discussed are: the development of nuclear industry, developments in nuclear technology and the joint research program, promotion of industrial activity, target program, health and safety, external relations, and the institutions of the community and inter-executive cooperation. (F.S.)

14129 (NP-16468(Vol.2)) DOCUMENTATION ATTACHED TO THE NINTH GENERAL REPORT ON THE ACTIVITIES OF THE [EUROPEAN ATOMIC ENERGY] COMMUNITY, MARCH 1965–FEBRUARY 1966. (European Atomic Energy Community). Apr. 1966. 280p. Dep. mn.

Thirty-eight reports are included in support of the information contained in the Euratom Ninth General Report. These reports include data on reactors, fuels, labeled molecules and radioisotopes, biology, controlled thermonuclear reactions, and health and safety. (F.S.)

14130 (ORNL-TM-1693(Pt.1)) A SYSTEM FOR BIOMEDICAL DATA MANAGEMENT (DATASYS). PART I. CONCEPTS AND FACILITIES. Katzan, H. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A hierarchically organized set of easy-to-use programs for use with data management problems is presented. The programming modules are under supervisory control of an executive program that routes work through the system. DATASYS is designed to facilitate the following types of operations: storing, updating, and manipulating data; selecting, modifying, and sorting data for analysis; summarizing data for verification or reports; retrieving and collating files of experimental data; automating routine calculations; and plotting data. (H.G.D.)

14131 (ORNL-TM-1693(Pt.4)) A SYSTEM FOR BIOMEDICAL DATA MANAGEMENT (DATASYS). PART IV. BIOPLOT. Kannan, Kay L. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

BIOPLOT, a system for biomedical data management, enables the user to plot graphs of discrete data without having to involve himself with the details of the electronic plotting equipment. Multiple curves may be generated on each graph. The user describes the work he wants performed with control statements and the plot tapes are generated by subroutines. Simple controls statements may be used to specify titles, type (i.e., LINEAR, LOG, SEMILOG), symbols (for designating data points), source of data (i.e., bulk storage or system input data), plotting mode (i.e., connected or disconnected points), and a data smoothing option. (auth)

14132 (ORNL-TM-1693(Pt.6)) A SYSTEM FOR BIOMEDICAL DATA MANAGEMENT (DATASYS). PART VI. BIOCALC. Katzan, H. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

BIOLAC is a computer program designed to relieve the scientist or technician of performing tedious calculations either by hand or with a desk calculator. Generally, the system contains provisions for reading in columns of data, performing calculations on them in column-wise fashion, and printing the data and results in a tabular format. More specifically, the program contains facilities for specifying variable names, constants, and column heading; for generating data internally; and for executing a wide variety of arithmetic operations and mathematical functions. (auth)

14133 (ORNL-TM-1740) PRIMER FOR THE SAFE USE OF LIQUID ALKALI METALS. Anderson, Frank A. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Characteristics of liquid metals and techniques for safe handling are discussed. Properties of alkali metals, design of liquid alkali metal experimental facilities, protective clothing, general safety precautions, fighting alkali metal fires, and first aid are discussed. (M.C.G.)

14134 (ORO-2733-4) TRIS(n-OCTYL)ARSINE OXIDE AS A REAGENT FOR LIQUID–LIQUID EXTRACTION. Linder, Donald Ernst (Texas Agricultural and Mechanical Univ., College Station). Jan. 1967. Contract AT(40-1)-2733. 102p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The extraction of $HClO_4$, HCl, HBr, HI, HNO_3, citric acid, and the metal ions; iron(III), zinc(II), cadmium(II), hafnium(IV) and

zirconium(IV) by trioctylarsine oxide (TOCASO) in benzene was investigated. A survey of the qualitative extraction of some 40 metal ions was also reported. From saturation loading curves it was found that the proton to TOCASO ratio was 2 : 1 when the acids were extracted by 0.1 M concentrations of the reagent in benzene. The metal ion systems were studied as a function of pH and reagent concentrations. (P.C.H.)

14135 (UCRL–16898, pp 14-21) BIOLOGICAL SPECIFICATION IN MEGAKARYOCYTES AND PLATELETS. Paulus, Jean-Michel (California Univ., Berkeley. Lawrence Radiation Lab.).

Data from recent studies on the biological specification in megakaryocytes and blood platelets are summarized. Data are included on the metabolic behavior of circulating platelets. (67 references.) (C.H.)

14136 (UCRL–16898, pp 42-52) INFLUENCE OF SEVERE HYPOXIA ON HUMAN ERYTHROPOIETIN. Siri, William E. (California Univ., Berkeley. Lawrence Radiation Lab.).

The total volume of red blood cells in the healthy person is controlled by the production of red cells whose rate, according to prevailing evidence, is mediated by erythropoietin. Whether or not primary control of erythropoiesis normally is vested in blood oxygen tension is not certain. It is clear, however, that low oxygen tension stimulates erythropoiesis to maintain a compensatory increase in red-cell volume that is related, in an ill-defined way, to degree of hypoxia. The influence of hypoxia on the regulation of red-cell volume was investigated in human subjects exposed to oxygen partial pressures ranging from 160 mm Hg (sea level) to 69 mm Hg (21,500 ft). Plasma-iron turnover, blood volume, and the ordinary hematological quantities were measured in Andean residents of 12,500 and 17,000 ft, and in climbers at sea level, at 17,800 ft, and at 21,500 ft, during an ascent of Mt. Everest. (C.H.)

14137 (UCRL–16898, pp 53-63) STUDIES ON THE THYMUS AND THE RECIRCULATING LYMPHOCYTE POOL. Schooley, John C.; Shrewsbury, Marvin M. (California Univ., Berkeley. Lawrence Radiation Lab.).

The temporal relationships between thymectomy and the first indication of a depression in thoracic duct lymphocyte outputs was studied in rats. The effects of transplantation of thymic tissue on the thoracic duct lymphocyte output and the effect of altering the total recirculating lymphocyte pool, utilizing the technique of parabiosis, were also studied. (38 references.) (C.H.)

14138 (UCRL–16898, pp 128-9) PLEIOTROPY AND POLYMORPHISM. King, Jack Lester (California Univ., Berkeley. Lawrence Radiation Lab.).

Recent work in theoretical population genetics has demonstrated, principally through the use of computer simulation of Mendelian populations, that genetic polymorphisms can be maintained through interactions between various factors that do not singly effect polymorphic balance. Thus neither linkage alone nor stabilizing selection alone leads to stable genetic diversity, but together these factors can maintain a polymorphic equilibrium. The interactions of stabilizing selection and mutation in this respect, and the effects of triple interactions of linkage, epistasis, and inbreeding in the maintenance of genetic diversity are discussed. It is pointed out that multigenic systems cannot be dealt with by analyzing the isolated effect of any single variable. Other interacting variables must also be considered in turn: pleiotropy, temporal fluctuations in selection intensities, environmental clines, compensation, and more. It is suggested that pleiotropy is potentially a potent factor toward the maintenance of genetic diversity. A simple model demonstrating this in the interaction of pleiotropy and stabilizing selection is presented. (C.H.)

14139 (UCRL–16898, pp 130-6) INCREASE IN PLASMA GROWTH-HORMONE LEVEL IN THE MONKEY FOLLOWING THE ADMINISTRATION OF SHEEP HYPOTHALMIC EXTRACTS. Garcia, Joseph F.; Geschwind, Irving I. (California Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study on the effects of intravenously injected sheep hypothalmic extracts on the content of pituitary growth hormone in the blood plasma of monkeys (Macaca mulatta). It was concluded that the observations reported support the concept that the secretion of anterior pituitary growth hormone is mediated by a hypothalmic neurohumoral factor. (C.H.)

14140 (Y-DA–1454) CARBON BINDER MODIFICATIONS. Marrow, G. B.; Taylor, A. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 11, 1967. Contract W-7405-eng-26. 9p. (CONF-660335–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Advanced Graphite Meeting, Los Alamos, N. Mex.

Several graphitizable organics were combined with the resin in attempting to achieve copolymerization and a change in structure from the poorly crystallized, highly cross linked structure of nongraphitic carbon toward the well-ordered layer structure of graphite. Structural changes in the carbon were monitored by x-ray diffraction techniques. The results indicated that a complete and orderly transition occurs from the thermosetting and nongraphitizable resin to the thermoplastic and completely graphitizable pitches. (P.C.H.)

14141 (Y-KA–17) TABULAR LINE-OF-BALANCE PRODUCTION CONTROL TECHNIQUE. Bostock, D. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 11, 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The operation of a tabular line-of-balance production control system used in production scheduling and control of weapon components is described. The advantages of the tabular line-of-balance system are obvious. First, it allows "management by exception". Only those areas where a minus status appears require attention. Second, the four report formats used are simple and explicit. Interpretation of the data is easy once an understanding of the basic system is obtained. Third, the reporting formats are reasonably flexible. For example, a sorting of data by operating areas rather than by program can be accomplished with little effort. The disadvantages of the system are: a high degree of accuracy is required of the basic input data; transmissions must be made and made accurately if the reports are to be used by front-line supervision for day-to-day operating decisions; part routing and the sequence of operations must adhere to the pattern prescribed by the lead-day network or the in-process inventory calculations will be meaningless; the total system, from scheduling to reporting of status, is reasonably flexible but frequent changes will increase the cost of the operation excessively; and the system requires detailed planning and preparation; thus, the system is time consuming and expensive. Its use is justified when attempting to control complex programs with many operations, parts, and diverse responsibilities. However, the tabular line-of-balance system is an invaluable management tool. (auth)

14142 (AEC-tr–6637/1-9) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers, Issues Nos. 1-9, 1962–1963. Translated from Vychisl. Sist., Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, (1962–1963). 398p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Issue Nos. 1-9 (1962-1963) of Computer Elements and Systems are presented. The papers included show research results on the various subjects related to the design and applications of high-power computer systems: general theory of computer systems, automation of computer design and assembly, numerical techniques for computer systems, physical principles of computer design, engineering principles of computers, information exchange between computer systems and peripheral equipment, and other related topics. (B.G.D.)

14143 (AEC-tr–6637/10-14) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers, Issues Nos. 10-14, 1964. Translated from Vychisl. Sist., Nos. 10, 11, 12, 13, 14, (1964). 455p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Issue Nos. 10-14 (1964) of Computer Elements and Systems are presented. The papers included show research results on various subjects related to the design and applications of high-power computer systems: general theory of computer systems, automation of computer design and assembly, numerical techniques for computer systems, physical principles of computer design, engineering principles of computers, information exchange between computer systems and peripheral equipment, and other typics. (B.G.D.)